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THE GEORGIAN BAY SHIP CANAL.

By J. G. G. Kerry.

After a long period of neglect the problems of inland navigation and the improvement of inland waterways have risen to a position of first importance in nearly every country in which transportation facilities are a matter of general concern. It is doubtful if any other engineering problem is so universally the subject of investigation on so large a scale. Italy, Austria, Germany and France have under consideration many large projects both for the improvement of existing waterways and for the building of new canals, and in both Great Britain and the United States the problems are deemed worthy of investigation by Governmental Commissions. In the latter country several canal projects have reached the active stage and the improvement of inland navigation is one of the most prominent features of the larger movement for the conservation of all natural resources. In common with all these other nations, Canada has a project for an inland waterway, but with this difference, that the agitation for water transportation facilities, which in other countries represents a movement to revive a waning trade or to escape from the bondage of excessive railway rates, in Canada is but the natural outcome of the enormous expansion of agricultural and industrial activity in the western part of the country, with whose rapidly increasing traffic the existing railways are inadequate to cope. The Georgian Bay Ship Canal project has been under careful investigation by the Canadian Government since 1904 and it is expected that Parliament will authorize its construction, on the lines of the report presented to Parliament last July, during the session about to open. In the following pages Mr. Kerry outlines the history of the Ottawa and French Rivers as a transportation route and describes the general features of the projected waterway. In a concluding section, to follow next month, he will discuss some of the larger problems in more detail and will examine the economic grounds for the construction of the canal.—THE EDITORS.

THE recent growth of population and industrial activity in the Canadian Provinces of Manitoba, Saskatchewan and Alberta has once more drawn the attention of the Canadian public to one of the oldest transportation routes on the continent, that which, following the Ottawa Valley, extends from sea level at Montreal via the Ottawa and French Rivers to the upper lake level at French Harbour in the Georgian Bay. Historical evidence shows that this was, in common with most of our great traffic routes, an established and much used pathway before the advent of European colonization

in North America. The Georgian Bay route, as it is commonly called, was used by the first white man to reach the upper lakes, Samuel de Champlain; and it was perhaps fitting that the surveys for a modern waterway along the natural route that he followed should be completed, and their results announced, while the tercentenary of his settlement in Quebec was being celebrated with pomp and circumstance by the representatives of three great nations.

Champlain founded Quebec in 1608 and his followers immediately commenced working their way westward by way of the Ottawa River, choosing this route because that via the St. Lawrence River was barred by the hostile Iroquois from their settlements in what is now the State of New York; this accounts for the early use of the northern route just as at a later date the hostility of the United States to British interests accounted for the building of the Rideau Canal in preference to the opening up of the navigation of the St. Lawrence River. By 1613 Champlain had penetrated inland as far as the present town of Pembroke, and in 1615 he made his memorable journey to the Georgian Bay and thence via the Trent Canal route to Lake Ontario. To-day the canalization of the Trent waters, commenced by the British Government about 1835 and then abandoned on account of political disturbances in Canada, is rapidly approaching completion, and the canalization of the waters of the Ottawa and French Rivers is one of the major projects under consideration by the Canadian Government.

If any question is asked regarding the late date at which the improvement of natural routes of such evident importance is being undertaken, it can be readily answered. Until the present decade Canada has had no need of transportation facilities of the highest order between the upper lakes and the Atlantic; her north and her northwest have lain unoccupied save by the trapper and the fur trader, and practically no all-Canadian traffic has been afloat on her inland seas. At the same time the uncompromising commercial hostility of the United States has prevented its western people from benefiting in any way by these great waterways, the American tariff laws making the handling of American import trade via Montreal a commercial impossibility.

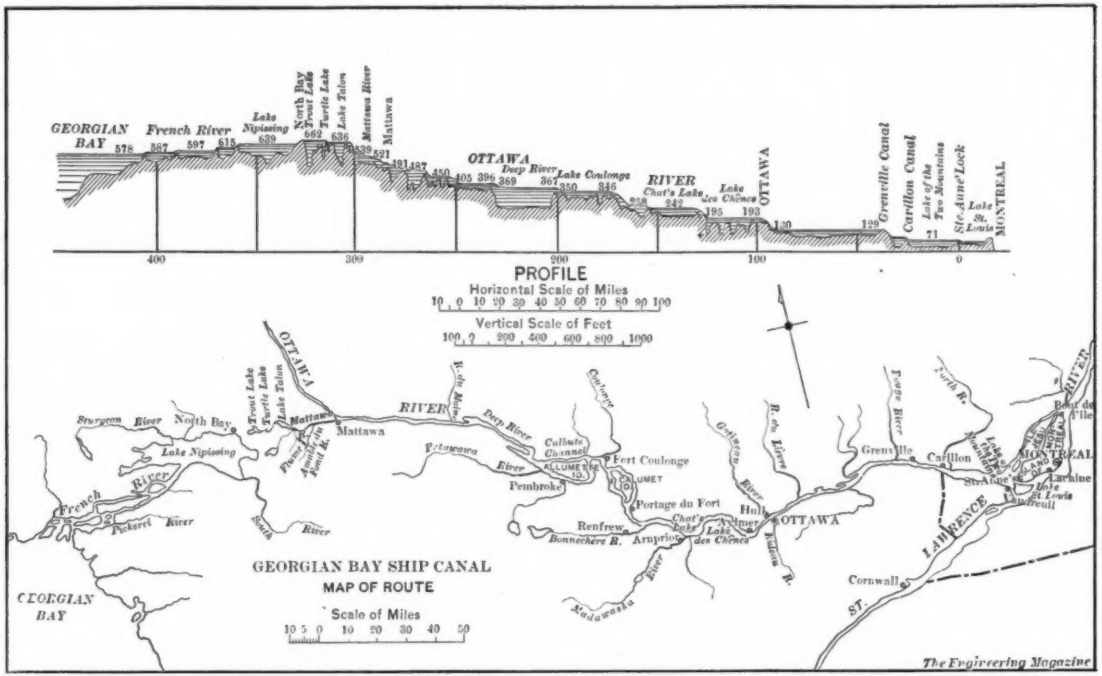
The natural advantages of the Ottawa Valley and Trent Valley routes were recognized at an early date by the Canadian railways and to-day the main line of the Canadian Pacific Railway follows Champlain's route up the Ottawa River, while the Grand Trunk Railway has for many years sent its western grain traffic by the path which that explorer travelled from the Georgian Bay to the eastern

end of Lake Ontario. The efficiency of the railway has materially delayed the advent of the canal.

Following Champlain to the west came the Jesuit missionaries, whose "Huron Mission" is perhaps the most picturesque and saddest incident in Canadian history. It is over two hundred and fifty years since that mission was wiped out in the annihilation by the Iroquois of the people to whom it was sent, but the writings of its members as recorded in the "Relations des Jesuits" made the Georgian Bay route familiar to western Europe centuries ago. It is worth noting that recently the main lines of the great lake and rail terminal which the Grand Trunk Railway is building at Tiffin on the Georgian Bay were deviated to avoid the ruins of the old headquarters of that pioneer mission.

By the same route came the Sieur de la Verendrye almost a century later on that expedition which brought him finally, as the discoverer of the far Northwest, to the Rocky Mountains. Later, for a short time after the conclusion of the American War of Independence in 1783, Montreal became the centre of the fur trade and the Ottawa Valley and the French River its highroad. The short and savage struggle for the commercial mastery of the Northwest between the Northwestern Fur Trading Company of Montreal and the Hudson Bay Company brought the route into a prominence which ceased when the conflict ended in the amalgamation of the two companies into that great corporation which for about half a century ruled over well nigh half the continent; from motives of policy that corporation closed up the route via the Ottawa River and sent all its traffic via Hudson's Bay in order that the Northwest might be forgotten and the trade monopoly that had been created by King Charles II perpetuated. The maps of the continent will, however, bear witness forever to the energy of the men of the Northwest Company who named the lands by their own names, and who, as the pioneer Canadian engineers, were first to open Lake Superior to through traffic by their canal construction at Sault Ste. Marie.

After the conclusion of the war of 1812, the great future of the western plains and the importance of the Great Lakes to their commercial development were recognized by both Briton and American. The State of New York, under the inspiration of De Witt Clinton, built the Erie Canal and almost simultaneously the British Government built the canals along the lower Ottawa River and the Rideau and commenced work on the navigation of the Trent River. With the construction of the Rideau Canal began the rise into importance of the city of Ottawa, and in 1837 its merchants sent out the first



PLAN AND PROFILE OF THE PROJECTED ROUTE OF THE GEORGIAN BAY SHIP CANAL.

expedition to study the possibilities of the Georgian Bay route for canal construction, the examination being made by Messrs. John McNaughton and Chas. P. Treadwell. Their report was favorable, but public interest at the time was centred on the betterment of the St. Lawrence Route, and the carrying out of the improvement of the latter, on the broad lines suggested by Colonel Philpotts R. E. in his historic report to Lord Durham, occupied the energies of the Canadas, as they were then called, until 1850.

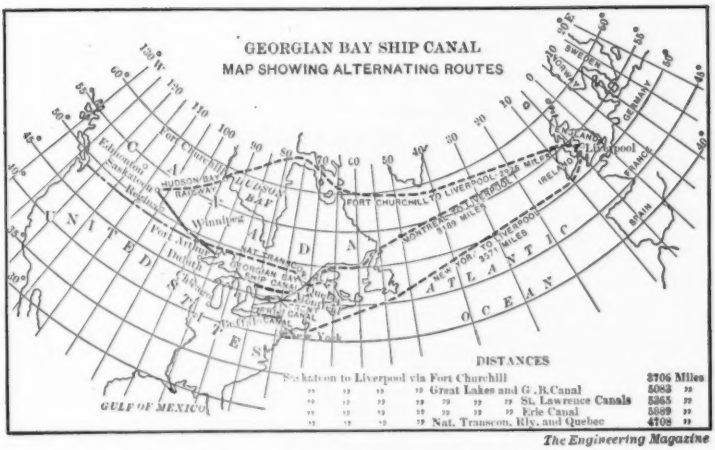
The following decade, 1850-1860, witnessed the first great era of railway building in Canada, but although the ablest and most far-seeing of Canadian engineers had realized at that time, and were openly stating, that the day of the canal as a general system of transportation had passed, the public was agitating for further canal construction. As a result of this agitation Mr. Walter Shanly was commissioned by Parliament to make a report upon the construction of a canal by the Georgian Bay route. The result of his investigation was made public in 1858. There was then no Canadian traffic to be carried on such a waterway, and west of Pembroke there were but few people resident along the route. The absence of any commercial reason for the immediate construction of the canal, other than a hope of diverting American traffic from American routes, perhaps accounts for the fact that the appropriation made did not provide sufficient funds for the completion of the surveys, and Mr. Shanly's report, was, therefore, somewhat of the nature of an interim report. The estimated cost of construction of a ten-foot waterway was given by him at $24,600,000, the general principle of his design being the cutting of canals at all points not already navigable, in preference to the canalization and regulation of the rivers. The problem of the summit level was met by Mr. Shanly with the bold suggestion, worthy of his great reputation as an engineer, that the level of Lake Nipissing should be raised until that ample lake became the summit level, a reasonable proposal in times when there was neither settlement nor improvement on its now busy shores.

Mr. Shanly's work was continued and completed in 1860 by Mr. T. C. Clarke who estimated the cost of construction of a twelve-foot waterway at $12,057,680, the decrease in the estimate being largely due to the adoption of considerably lower unit prices for the necessary excavation. Mr. Clarke favored, where possible, the use of canalized river in preference to canal. The feasibility of the project was now established beyond question; it remained only to demonstrate that there was a commercial need sufficiently great to justify

the expenditure called for. No such need existed in 1860 and up to the present day the volume of traffic that will be carried by this waterway has been, and is, a matter of controversy.

From 1860 to 1890 the attention of the Canadian people was fully occupied with projects of national importance, the Confederation of the Dominion, the construction of the Intercolonial and Canadian Pacific Railways and the opening up of the fourteen-foot navigation from the Great Lakes to the Atlantic via the St. Lawrence River being the most prominent undertakings that were completed or well advanced during that period. Agitation in favour of the construction of the Georgian Bay Ship Canal, however, recommenced about 1890, mainly on the part of promoters and contractors with headquarters in the city of Ottawa. Mr. T. C. Clarke, who had for long been one of the principal figures in the American engineering world, was again called upon to report. In 1898 he recommended the adoption of a barge canal with fourteen-foot depth on the lock sills but questioned the practical utility of any such waterway in view of the small amount of Canadian traffic on the Great Lakes. He modified his earlier plans by abandoning the idea of raising the level of Lake Nipissing, thirty miles of the roadbed of the Canadian Pacific Railway and the town site of North Bay lying within the flood-line contour, and he proposed instead the lowering of the small summit lakes, Trout Lake and Turtle Lake, to the level of Lake Nipissing.

The idea of the navigation of the Great Lakes by ocean-going vessels has always been a most attractive one and for over a century it has found many enthusiastic advocates both in Canada and in the United States. It was the basis of Colonel Philpott's report in 1840, the *raison d'être* of the international "Deep Waterways Commission" of 1896 and the underlying principle of the early designs for the Georgian Bay Canal. In more recent proposals, however, it has been recognized that the conditions of navigation upon the ocean are so different from those which obtain on the Great Lakes that the same type of vessel cannot be economically used in both services. The purpose of the Georgian Bay Ship Canal as now projected is to bring the lake carrier to a point where she can trans-ship directly into the ocean liner. As a result of steady agitation a complete survey for such a project was authorized by the Canadian Government in 1904 and an interim report on the survey was laid before the Houses of Parliament in July of last year. It is probable that the final report giving in detail all results of the surveys will be ready for presentation during the coming session of Parliament.


GEORGIAN BAY SHIP CANAL
MAP SHOWING ALTERNATING ROUTES
UNITED STATES
ATLANTIC
OCEAN
GULF OF MEXICO
FORT CHURCHILL TO LIVERPOOL 3706 MILES
MONTREAL TO LIVERPOOL 3189 MILES
QUEBEC TO LIVERPOOL 3271 MILES
DISTANCES
Saskatoon to Liverpool via Fort Churchill 2706 Miles
" " " " Great Lakes and G. B. Canal 5083 "
" " " " St. Lawrence Canals 5365 "
" " " " Erie Canal 5869 "
" " " " Nat. Transcon. Rly. and Quebec 4708 "

The Engineering Magazine

MAP SHOWING ALTERNATIVE ROUTES BETWEEN WESTERN CANADA AND EUROPE.

It will be well before proceeding further to review, very briefly, the physical characteristics of the route of this proposed waterway. A glance at the accompanying maps and profile will show both its directness and the singular chain of deep lakes and rivers lying along it. The late A. M. Wellington, who was for years one of the most enthusiastic advocates of this route, has described it as "the finest place on the globe for a deep-water canal." Long reaches of navigable water occur, which need no improvement whatever. In fact the existing waterway is a succession of deep, almost currentless pools connected together by short streams broken by rapids and waterfalls. For this reason the water level does not fluctuate with great rapidity, seldom rising more than three inches in twenty-four hours for any considerable number of days in succession.

Geologically and topographically the character of the surrounding country is broadly divided at a point close to the city of Ottawa. To the westward lies a Archæan region composed mostly of diorite, gneiss and granite, abrupt, broken and bare and with well defined and deep valleys; in this section are occasional large patches of level-lying and fertile Cambro-Silurian country. To the eastward is a Cambro-Silurian region bordered close to the north shore of the Ottawa River by Archæan; this region is generally level-lying but it is divided by well-defined outcrops which form the natural dams that hold back the long deep-water reaches of the lower river. Permanent raising of the water levels will not be objectionable in the western section where the channels are narrow and deep, but in the

eastern section the river shores are flat, low and well-cultivated and flooding is therefore an economic impossibility.

As in the case of all northern canals, the climatic conditions, which will limit the period of navigation to approximately seven months, are the most serious drawbacks to the efficient working of the route. It is estimated by the engineers that the waterway will be open, on an average, for 210 days in the year, this estimate agreeing closely with the figures for Lake Nipissing given by the Deep Waterways Commission in 1896. It was estimated at that time that Lake Nipissing would be closed by ice from November 29 to May 3, a period of 155 days. That climate will place the Georgian Bay Ship Canal at a disadvantage when compared with the existing St. Lawrence Canals can be readily seen from the following dates of the opening and closing of navigation taken from the Report of the Deep Waterways Commission:

Place.	Average Date of Closing.	Average Date of Opening.
Port Arthur	December 21	May 1
Sault Ste. Marie.....	December 2	April 30
Welland Canal	December 10	April 17
Lake Nipissing	November 19	May 3
Lachine Canal (Montreal).	December 2	April 30

It is hardly possible from these dates to avoid the conclusion that the northern waterway will have a navigation season nearly a fortnight shorter than that which can be obtained for the proposed enlarged canals on the St. Lawrence route.

A mental picture of the route, then, will show between Montreal and Ottawa, or say one-fourth of the length, a broad placid river broken by three groups of rapids and flowing between fertile and well-cultivated shores. This section has been navigable for nearly eighty years and the present enterprise will merely enlarge the scale of the navigation. For 190 miles further to the westward, the route still follows the Ottawa River. This section has been long the highway of the lumberman but has remained little known to general commerce. The broad placid pools and well-settled banks are still found but the river is broken more frequently, more roughly and for longer distances by the rapids, the character of the valley changing swiftly with the change in its geology and islands of great size becoming a feature of the river. Old and well established towns are on the banks but settlement is by no means dense. It is hardly 30 years since the Canadian Pacific Railway reached Mattawa, the western end of the section. The building of the Ship Canal would give to this part of the river opportunities for development which it has never yet had, all through navigation now terminating at Ottawa.

The third section from the Ottawa River to the Georgian Bay runs through a succession of pools with high rocky banks. It is a much broken region with its streams sometimes divided into two or three parallel branches, its areas little settled and less cultivated, and, like most Archæan country, it is not attractive to the agriculturalist. It was unopened to commerce in any effective way until the Canadian Pacific Railway was built through it twenty-five years ago.

The surveys, which have been under the general direction of Mr. E. Lafleur, Chief Engineer of the Department of Public Works, and Mr. A. St. Laurent, Engineer in Charge of the Georgian Bay Canal Survey, have been carried through with great thoroughness, the work done including general surveys, precision levels, borings, soundings, establishment of water levels at the various stages, studies of river regulation, hydrographic surveys of tributary watersheds, studies of power development, of the requirements of modern navigation, of the handling of large freighters, and of the details of lock construction. No plans have as yet been made public and the drawings accompanying this article are prepared from the results of earlier surveys; in major detail the design can be but little altered, the natural features being so well marked and on so grand a scale.

The interim report places the length of the waterway at 440 miles and for over 410 miles it will not be canal but lake or canalized river. The general route has already been sufficiently described. The stretches of canal are found near the summit and near Montreal, but it is questionable whether the latter sections will ever be built or whether the locality does not justify a much bolder scheme of river improvement in spite of the expense entailed. The cut across the divide between the waters of the French and Ottawa Rivers is 3½ miles long, and a stretch of 3 miles of canal is projected in the valley of the Mattawa River where the fall is comparatively rapid. These are the longest sections of actual canal except the section near Montreal. From the foot of the Lake of Two Mountains, out of which the Ottawa flows to its final discharge into the St. Lawrence in four separate branches, two routes are projected, the one following Lake St. Louis and the St. Lawrence River to Montreal, and the other the valley of the Back River or Rivière des Prairies. The Back River is the main stream of the Ottawa and flows at the back of the Island of Montreal, discharging into the St. Lawrence at Bout de l'Ile, a point about 17 miles east of the centre of Montreal harbour, Owing to the expense of right of way and the artificial obstacles that are necessarily found in the environs of a great city, about 5

miles of actual canal have been recommended on the first route and about 11 miles on the second.

In the natural waterways about 332 miles require no improvement whatsoever, for an additional 14 miles a broad waterway can be secured by the cutting off of a few small shoals and there will be about 66 miles of channel or submerged canal to be built. Locks of the ordinary type are to be used, the dimensions of the lock chambers being given as 650 feet by 65 feet by 22 feet on the mitre sills. It is not considered that there will be any lake vessels designed in the immediate future to draw more than 20 feet of water. It is true that the St. Mary River channel is being deepened to 25 feet and that the Canadian lake terminals are being dredged to the same standard, but the extra 5 feet are considered necessary to provide for the free movement of vessels drawing 20 feet and also for those sudden falls in the lake levels which occasionally occur as a result of severe wind storms. 20-foot navigation at all stages is still to be secured in the channels connecting the Great Lakes and only the most important harbours can dock vessels of this draught. It will be noted that the locks are designed to handle self-propelling vessels rather than tows; and in their proportions they are in marked contrast to the St. Lawrence River locks which were designed by the Canal Commission of 1870. The latter are 270 feet by 45 feet in plan and Mr. T. C. Keefer has suggested that they were especially intended to provide for Noah's ark, no other vessel of his knowledge having the same relative dimensions.

Forty-five main dams will be required in all, not including those that may be built for regulating the discharge of tributary streams. Where the river flow is abundant it is proposed to adopt the rock-fill type of dam, but the economic value of power has been advancing so rapidly during the last fifteen years that it is questionable whether the use of so wasteful a device will be permitted. The regulated water levels in the pools will be maintained by the use of stop logs as is customary in Canadian practice. In a few places the Stony patent sluices may be introduced.

Both from the standpoint of navigation and for the development of power the regulation of the discharge of the Ottawa River is most desirable. The units involved in its control are startling. The records show that the minimum discharge near Ottawa in recent years has not been much greater than 10,000 cubic feet per second and that maxima as high as 250,000 cubic feet per second have been reached. It is hoped that the discharge may be so effectively con-

trolled that it will never be less at this point than 90,000 cubic feet per second and never more than 120,000 cubic feet per second. The economic value of this regulation is effectively set forth in the interim report by the remark that the potential low-water horse power on the two main rivers will be increased by it from about 150,000 horse power to nearly 1,000,000 horse power.

It is not easy at this date to grasp the fact that the watershed of the Ottawa River is an almost unknown and uninhabited land. It is mainly in the province of Quebec and far to the north of the river itself which in reality skirts it southern edge; its northern boundary is the height of land between Hudson's Bay and the St. Lawrence River waters. For at least three generations this district has been given over to the lumberman and few and limited in area are the farm clearings in it. Engineering data for the design of the regulating works on the tributaries of the main river are therefore not in existence and exhaustive surveys such as are needed to secure these data cannot now be conducted at reasonable expense except perhaps in the depth of winter. This difficulty will, however, be very greatly reduced when the National Transcontinental Railway, now building, is opened to traffic, as its location crosses the head waters of nearly all the principal tributaries of the Ottawa. It will provide a convenient base for the carrying out of a hydrographic and topographic survey of the upper watershed.

Much attention has already been given to the general hydrography of the river and it is estimated that at a cost of less than $500,000 the well-known lakes Temiscamingue, Keepawa, Quinze, Barrière, Kinejiskaskatic, Turn Back, Askikwaj and Grand Lake Victoria, might be converted into storage reservoirs, and a storage of perhaps 150 billion cubic feet of water obtained. The regulative effect of these great storage basins and the ease with which the discharge of the waters from them can be controlled are too obvious to call for comment. A more picturesque suggestion has been made for the control of the flood discharge, based on the fact that the headwaters of the Ottawa itself lie far to the eastward where the stream flows in a bed of high elevation between the two great ridges which form the height of land between the St. Lawrence River and Hudson's Bay. It is suggested that a large portion of the flood waters should be diverted across the height of land and into the streams discharging into Hudson's Bay. Pending the opening up and further survey of the watershed such a proposal may be regarded as an interesting speculation.

THE DEVELOPMENT OF THE SMALL STEAM TURBINE.

By Chas. A. Howard.

A preceding article by Mr. Howard, in our December issue, contrasted the principal features of design and construction in the leading types of small steam turbine in use in the United States. This concluding paper is concerned with the service applications to which this form of prime mover is best suited.—THE EDITORS.

THE field to which the small steam turbine is adapted is broader in extent than that of any other source of motive power with the exception of the electric motor, which can be used to greater or less advantage under almost any conditions. The great extension in the use of the turbine for commercial purposes in sizes under 300 horse power extends back but a very few years, so that it has scarcely begun to open up its unquestionably broad field. When these small turbines were first extensively placed on the market for machinery driving, their promoters picked for the place to start the equipment of the auxiliaries of steam-power plants with prime movers. During this short time, they have been installed in large numbers for driving exciters, centrifugal boiler-feed pumps, centrifugal hotwell pumps for condensers, fans for forced and induced draft, and also in many cases in small plants for driving the main generators themselves.

For steam-driven exciters, the steam turbine is the ideal type of prime mover, and as every power plant where constancy of service is a desideratum, except possibly where several are tied in together in a large system, should have at least one steam-driven exciter, there is a place in nearly every plant for at least one small steam turbine. The exciter is invariably a small unit and the speed at which it operates best is high, much higher than is economically possible of attainment with small reciprocating engines which are limited even in the smallest sizes to about 350 to 400 revolutions per minute as a maximum. Speed regulation of the turbine within 1½ to 2 per cent is easily attainable and this is as close as is necessary or desirable for the exciter. As there are only two bearings to keep in order and no other sliding or rubbing surfaces in contact, it can be easily seen that both the wear and the attendance necessary are much less than would be

the case with a reciprocating engine, a fact which has been brought out and proven in operation.

The use of multi-stage centrifugal pumps for boiler-feeding purposes is only of comparatively recent date, but the great success of all those which have been installed points to a large increase in their use in the immediate future. On account of the high heads against which these pumps are run, their speed is far above the maximum limit of a reciprocating engine, so that it is a question of a steam turbine or an electric motor. If there is use for the exhaust steam the turbine is unquestionably the better proposition; if there is no demand for the exhaust steam it may work out better for the motor, but it should be remembered and considered that these pumps are generally located in the boiler-house basement where the ashes fly thick, and that they will get very little attention and what they do get will be of a very poor quality. In almost every plant, however, there is a demand for the exhaust steam for heating the feed water, and frequently also for heating, drying, and other uses, so that it is usually more economical when centrifugal feed pumps are used to drive them by steam turbines.

In connection with condenser instaliations there is a very large field for the turbine, especially when the condensers are of large size, and separate wet and dry air pumps are used. Many of the largest and most modern surface-condenser plants are using turbine-driven centrifugal pumps to remove the condensed steam from the hot well and throw it over into the heaters or overboard as conditions demand. Condensers using turbine-driven centrifugal circulating pumps are now being built and show a large saving in the space taken up by the condensing machinery. At the present time, there is no commercially successful dry vacuum pump in use, but everything points to a satisfactory development of this apparatus at an early date. This machine, if successful, will call for a steam turbine for its motive power.

For driving the forced-draft fans in a boiler plant, the turbine offers important advantages. By increasing the speed of rotation the size of the fan is largely reduced. Fans have recently been developed which run at a higher efficiency at a comparatively high speed than the larger fans can do at their slow rotative speed. The maintenance of engines driving forced-draft fans is usually a very expensive item, especially in large plants, and this can be made almost to disappear by the substitution of a turbine.

The successful development of the multi-stage centrifugal pump has opened up a new field for the steam turbine for pumping the water supply of cities, and this shows promise of a very extensive growth. Of course neither the mechanical nor the thermodynamic efficiency of the turbine-driven multi-stage centrifugal pump is to be compared with that of the high-duty pumping engine, but the initial cost of the former for a given capacity, the maintenance expense and the cost of the labor required for operation are very much less, so that in many cases the turbine pump will work out to be more economical. Every installation is a special problem in this regard and if the saving in fixed charges and labor of the turbine pump is greater than the saving in steam of the high-duty pumping engine, then the former will be the unit to install. Under some circumstances the problem will work out one way, under others, in another. One point, however, which is of the utmost importance in making a decision as to the type of pump to be installed is the question of water hammer. This is entirely avoided when centrifugal pumps are used.

In small water works where the choice is between the centrifugal pump and the low-duty, compound, duplex pump, the former can at least hold its own in initial cost and will in all probability be cheaper for a given capacity. The maintenance expense, cost of labor for operation, and the steam consumption are all less in the case of the turbine-driven unit, so that this is almost invariably the best installation for a small water-works system where low-duty pumps are the only alternative, except of course when the centrifugal pumps can be connected to motors driven by electric power purchased at advantageous rates, thus doing away with the boiler plant.

Another very promising field for future development, in which little has as yet been done, is the ventilation of mines. The present practice in this branch of engineering is to install at a mine one or more fans having wheels or runners from six to thirty-five feet in diameter and running at very slow speed, generally driven by either one or two Corliss engines, one on one side of the fan and one on the other. The connecting rod of one of these engines is generally taken down and the engine held in reserve in case any accident happens to its mate. These units are very expensive in first cost, much more so than fans used for other purposes, and their running expenses, while comparatively low, are still considerably in excess of those of a turbine-driven unit. The question of safety, which can be secured only by continuous operation of the fan, is of paramount importance in mine work, so continuity of

operation is the first thing to be considered. About the only possible accidents which can happen to a turbine are derangement of the governor and breaking of the shaft, and both of these are equally liable to happen to a reciprocating engine. When one stops to think of the failures which are possible, and which are continually taking place, in engines, there can be little question about the reliability of a properly constructed and properly erected steam turbine. The breaking of a crank, connecting rod, crosshead, eccentric rod or strap, or cylinder head, the twisting off of a valve stem or any one of a score of other breakages of parts will put a reciprocating engine out of commission.

Of course, in mining plants, two engines are generally used on each fan, but two separate, complete, turbine-driven units could be installed at a much lower cost than a large single fan driven by two engines of the type generally employed for this service and would provide duplicate fans as well as duplicate engines. With such an installation, in case anything went wrong with one unit, it would only be necessary to open the throttle and turn steam into the other unit, whereas with the system at present in use, the rod of one engine must be taken down and that of the other set up before the fan can be started again. When it is considered that the fan houses are frequently at some distance from the main works at the head of the shaft, it will be seen that this involves some little time, and some danger to the miners below.

Another line in which some work has been done but which offers extensive opportunities for the turbine in the future is the driving of generators for steam-railroad train lighting. There are three distinct systems of electric train lighting, each having its good points and each its disadvantages. These are, first, the axle system, in which the generator is driven from the axle of the car; second, the storage-battery system, in which the batteries are placed under the cars and are charged periodically from an external source of current; and, third, the system in which a steam-driven generator is placed in the baggage car or on the locomotive.

The axle-driven system might seem at first to be the ideal one, as each car could have its own independent source of supply and would not be dependent on any other car or on the locomotive for light. It is necessary in this system, however, to provide storage batteries under each car to supply the latter with light when it is standing still and for the proper regulation of the voltage on the lights. In addition, there must be an automatic regulator to maintain the

proper charging current for the batteries, irrespective of the necessarily variable speed of the generator, switches to prevent the discharge of the batteries through the generator and to keep the polarity of the charging current right, no matter in what direction the generator revolves, and also a compensating regulator to take care of the difference in voltage between the charging current and the discharging current from the batteries to the lamps. It can be seen that this is an exceedingly complicated mechanism, and as railroad operating men generally know little of, and have still less use for, electrical apparatus, it can hardly be said that there is the highest possibility of this system coming into extensive use.

In the storage-battery system, batteries charged after each trip from plants at the terminals are placed under each car. They require from six to eight hours for charging and will give light for only about eight hours. The maintenance cost and weight of the batteries in this system are important, not to mention the fact that the cars are tied up at the charging plant for six or eight hours after each trip.

This leaves as the leading commercial system for future development, and the only one whose use is being extended to any extent today, that in which the current is supplied by a steam-driven generator in the baggage car or on the locomotive. Storage batteries are necessary to carry the lights when the engine leaves the train, but as the interval during which light must be supplied at the time when the engine is detached from the train is very short, these batteries can be very small. The only logical place for the generating unit is on the locomotive and not in the baggage car. When placed in the latter it is separated from the steam supply and has to be connected with it by a steam coupling under high pressure, always a great source of trouble and annoyance. It is frequently desirable with heavy trains to run the baggage cars all together in one section and the passenger cars in another, but if the lighting units are in the baggage cars, one of the latter must be added to the heavy train of coaches and separated from the rest of the baggage. The engineer on the locomotive is the only member of the train crew fitted to look after the lighting unit. It should be placed under his care and not under the care of a man whose chief duty is to handle trunks.

On account of limitations of space, the steam turbine is the only prime mover adapted to driving the dynamo for lighting when the latter is placed on the locomotive. Units of about 25-kilowatts capacity are generally used and these are compact enough to be con-

veniently placed on top of the boiler, either between the head light and the stack or else further back, sometimes just in front of the cab. In cases where it may seem desirable for exceptional reasons to place the lighting plant in the baggage car, the turbine-driven unit is much the more satisfactory as it can be run by a much less capable man than is necessary to handle a reciprocating engine and in addition it takes up much less space. Electricity for train lighting has come into very extensive use during the past two years and it will be used even more extensively in the future, on account of the great danger of explosion and fire, in case of any otherwise trivial accident, inseparable from the use of gas under a pressure of 175 pounds per square inch.

In marine work but little has been done with small turbines. In fact it is for only a few years that the large turbines have been used to any extent on shipboard. The small machines are applicable to driving centrifugal pumps for feed purposes and circulating pumps for the condensers, just the same as in service on land. They are also well adapted for driving the forced-draft fans as these are in close proximity to the boilers; but electric motors are generally much better for driving the ventilating fans at a distance from the boilers as it is much easier to run conduits for wires than steam and exhaust pipes.

One of the most popular uses of the steam turbine up to the present date is for driving blowers for gas works and foundry cupolas. In gas-works service, it is necessary to stop and start the blowers very frequently and they must be started quickly. The turbine does not have to be warmed up, and if water is carried into it by the steam, it merely slows the machine down a little, whereas with a reciprocating engine, it would knock out the cylinder head. Blowers direct connected to turbines running from 2,500 to 3,500 revolutions per minute can be brought from a standing start up to full speed in from seven to ten seconds. For supplying the blast in forge shops and foundries it is necessary to run the blowers at very high speed to get the necessary pressure and this speed can be conveniently obtained only by direct connection to a turbine. When belts are used, their slipping and stretching and objectionable noise are always sources of annoyance.

For small isolated electric-power plants, the small turbines are pressing the very best reciprocating engines very hard for first place. A large number have been installed for this service and the results in general have been very satisfactory. Of course, mistakes are made

occasionally, and some turbines have been installed at a disadvantage, under conditions which would have perhaps been better for an engine, but the few instances in which the results have not been all that was expected should not condemn the turbine as a machine when properly installed and under the right conditions. I have in mind one interesting incident which may give a little food for thought. A plant in a certain office building which furnished the power for lighting, elevators and the various other requirements of the building needed an additional unit. The superintendent, who was too much of a good business man to be a very good engineer, decided that turbines were the latest development in prime movers, so he sent invitations to bid to the various manufacturers of turbines. When the question of steam pressure and back pressure came up, he dug up the old contract on which the boilers were bought and found that the guaranteed steam pressure was 175 pounds per square inch; this he specified as the pressure at the turbine. As to the back pressure, he decided that, since the turbine would exhaust through a pipe which led to a riser to the roof of the building, about 15 stories high, and since the riser opened into the atmosphere, there would be no back pressure and so stated in his specification.

The turbine was erected and ran with a pressure at the throttle of about 150 pounds and a back pressure of 4 pounds per square inch. Naturally under these conditions it did not give very good economy as the nozzles were designed for 175 pounds of steam and no back pressure above the atmosphere. The back pressure especially makes a very great difference in the economy of the turbine. When the superintendent discovered that to run this turbine took several barrels of coal per week more than was necessary with his engine, which was of one of the very best makes and designed for the pressures under which it was running, he declared that the turbine was no good and wanted it thrown out in spite of the protests of the engineer who was running the plant.

In comparing the turbine and the reciprocating engine as to their relative advantages under the most general conditions, the turbine seems to be superior on a majority of points. In individual cases there are always particular conditions which have a greater or less influence on the choice of the type of steam motor to be installed. The most important consideration in this connection is the speed at which the driven shaft must run. When the choice of motor is limited to a steam turbine or a reciprocating engine, speed is very nearly the sole determining factor. It is impracticable to run engines much

above 400 revolutions per minute and almost equally impracticable to run turbines at a slower speed, if steam economy is any object at all. This seems very simple, but unfortunately it does not work out quite so easily. Almost invariably the unit, whether it be a generating unit, a pump or a blower, is considered as a whole and the question resolves itself into one which involves the machine to be driven even more than it does the prime mover itself. The natural rotative speed of all machines which depend upon centrifugal force for their operation is high, and the same is true of electric generators. Except for very large volumes and low heads, centrifugal pumps and fans are required to be run at speeds above the limit of the steam engine. Even when the volume and head are of such proportions as will permit direct connection to an engine, the cases are rare in which a much smaller, more compact and less costly high-speed turbine-driven machine cannot be provided that will operate equally as well as, and probably better than, the slower and larger unit.

Steam consumption is a point which is very important in some cases and which need not be considered in others. The latest well-designed turbines of under 300 horse power, which are generally classed as small turbines, have at the speeds for which they are designed nearly as good steam economy as is obtained from the best makes of reciprocating engines under their best conditions; and when all the factors influencing economy are taken into consideration, it is probable that in general the turbine will show to better advantage than the engine. In quoting tests of performance, the steam consumption of reciprocating engines is generally given in pounds of steam per indicated horse power per hour, while it is necessary to measure the steam consumption of turbines in pounds per brake horse power per hour. This little matter makes a difference of from 10 to 25 per cent in favor of the turbine when a comparison is made merely on the horse-power-hour basis. A new engine may be more economical than a new turbine, but in the long run the relative economy of the two is usually changed to a very marked extent after a certain period of operation.

The only wearing surfaces on a turbine are the shaft bearings. As the weights supported are light, the wear is very small and has almost no effect on the steam consumption. In the reciprocating engine, however, even the slightest wear of the valve, valve seat or piston rings will cause leakage which, though not perceptible from the outside, generally increases greatly with the age of the engine.

Of course it must be considered that the condition of an engine will be governed to a great extent by the engineer who has charge of it. In turbine operation, although it is much better for a turbine to be handled by a capable engineer rather than by a poor man, high-class supervision is not nearly so essential as is the case with a reciprocating engine. The principal thing which a man operating a turbine should be taught is to let it alone. There are two shaft bearings which need to be filled with oil every few days and as that is about all the attention a turbine needs, the labor required for operation is much less than is necessary on an engine.

A very important point in cases where the exhaust is returned to the boilers either by running into a surface condenser or by being condensed in a heater is the question of oil in the exhaust steam. The exhaust from a turbine contains no oil whatever, while the oil used for lubricating the pistons in the cylinders of an engine is always present in the exhaust steam in considerable quantities.

The maintenance cost of a turbine will obviously be much less than that of an engine and this has been abundantly proved by experience. As the turbine has only the two shaft bearings where any wear can occur, the repairs must of necessity be less than those required on a reciprocating engine in which it is necessary to keep cylinders bored, valves and seats properly scraped, crossheads in line and the wear taken up on all pins and on the heavy shaft bearings. The first cost of a turbine is sometimes more and sometimes much less than the cost of an engine, according to the size and speed. When the cost of the complete unit for a given service is considered, however, whether it be fan, generator or pump, the total cost will in almost every instance be much lower for the higher-speed turbine-driven installation, which will also occupy very much less space.

It must not be inferred that the advent of the steam turbine will drive the engine out of use. This will probably never take place. The steam engine as built today is probably more intelligently and carefully designed and constructed and better and more widely known than any other machine in use. There are many conditions to which the reciprocating engine will continue to be better adapted than any other type of prime mover. When electricity came into extensive use for lighting, many people thought that the gas companies would have to go out of business, but they are still just as busy as ever. In their future development the engine and the turbine should each seek the field which it can fill best.

METALLURGICAL PRACTICE IN THE GOLD FIELDS OF WEST AUSTRALIA.

By Arthur Selwyn-Brown.

In our issue for last November, Mr. Selwyn-Brown reviewed the geological features, development, and gold production of the principal Australian fields. He completes the study here by a summary of the special milling and metallurgical methods adopted for the treatment of these often difficult ores.—THE EDITORS.

A GREAT impetus was given to gold mining in West Australia, by the discovery of the Coolgardie and Kalgoorlie fields in 1893 and 1894 respectively. At that time metallurgists were developing the cyanide process in the Transvaal and New Zealand, and perfecting the chlorination process in Colorado, New South Wales and Queensland. The mines in West Australia when first opened were very rich and the gold was free and easily saved. Simple crushing and amalgamation processes were, consequently, adopted for treating the ores. The greatest difficulties experienced by the metallurgists arose from the scarcity of water. The mines were situated in arid districts, between 300 and 400 miles westward from the sea and coastal rivers, and the only sources of supply in the mining camps were the mine waters, mineral springs and desert salt-pans. All the ground water was full of alkali and the miners were compelled to distil the alkali water to obtain supplies for drinking and domestic purposes. The scarcity, however, was remedied by the Government early in 1903.

THE WATER SUPPLY OF THE GOLD FIELDS.

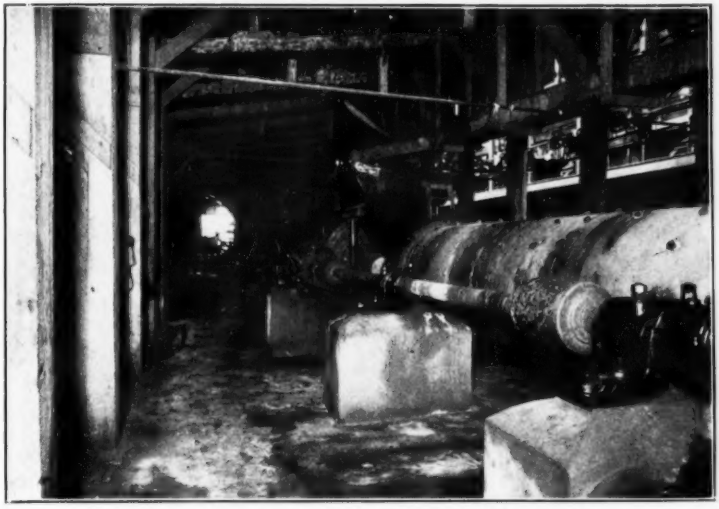
The Government clearly recognized the economic value of the gold discoveries and, while the mining boom was on, boldly undertook to supply the principal mining communities with good water. Its scheme was, in addition to being the greatest of its kind, unique in other respects. The estimated requirements of the fields amounted to 5,000,000 gallons of water per day. After numerous surveys had been made, it was determined to run a weir across the Helena River, near Mundaring, and pump the water thus collected, in 2½-foot rivetted steel conduits, a distance of 351½ miles to Bulla Bulling. A concrete weir 760 feet in width and 100 feet in height was constructed across the river. This formed a reservoir with a storage

capacity of 4,600,000,000 gallons, and a daily output capacity of 5,000,000 gallons. The main service reservoir from which the towns and mines of the gold fields are supplied is situated at Bulla Bulling, 21 miles eastward from Coolgardie. This reservoir has an elevation of 1,290 feet above the level of the Mundaring reservoir. The water is pumped from Mundaring to the Bulla Bulling reservoir by steam pumps operating in eight sections and from as many intermediate reservoirs or storage tanks. These pumping stations handle daily over 5,000,000 gallons of water, weighing approximately 22,300 tons. From Bulla Bulling the water is distributed to numerous centers by gravity through steel conduits. The scheme, at present, embraces 14 large reservoirs with a combined storage capacity of 31,500,000 gallons, eight main pumping plants and numerous minor service reservoirs and pumping stations in the neighborhood of the towns and mining districts which depend upon the project for their water. The total cost of the scheme was $15,000,000. The income from the sale of water pays interest on the capital invested, and three per cent per annum towards a sinking fund. The supervision of the scheme is exercised by the Department of Mines, and the actual management of the distribution of the water on the various fields is entrusted to various lessees and water trusts. The water supplied is of the finest quality for all purposes and the capacity of the service is adequate. The remarkable results of this great scheme, undertaken in the face of many difficulties for purely economic purposes, has fully justified the boldness of the engineers who planned it, and the government that financed it. Without the adequate water supply which it guarantees it would have been impossible for the gold fields to have been developed to anything like their present extent.

Metallurgical Methods.

By the time the water scheme was completed, the principal mines had been developed to a considerable depth. In many of them, especially at Kalgoorlie, sulphides and tellurides were met with below the water level. This necessitated the modification of the simple amalgamation process and the adoption of improved metallurgical methods. By this time both the chlorination and cyanide processes had been brought to a high degree of efficiency. The chlorination process, as developed at the Mount Morgan Mine, Queensland, offered a solution of the sulphide problems at Kalgoorlie, and it was adopted at several of the mines. The high price of fuel for roasting the ore, however, prevented its general adoption. The cyanide process, in which roasting was not necessary, offered advantages, but

neither the South African nor the New Zealand methods of cyaniding were found suitable in West Australia. New methods had to be worked out to adapt cyaniding to the treatment of the local ores. This has been done so successfully that West Australian cyanide practice is now recognized to be in advance of that of nearly ali other mining fields.



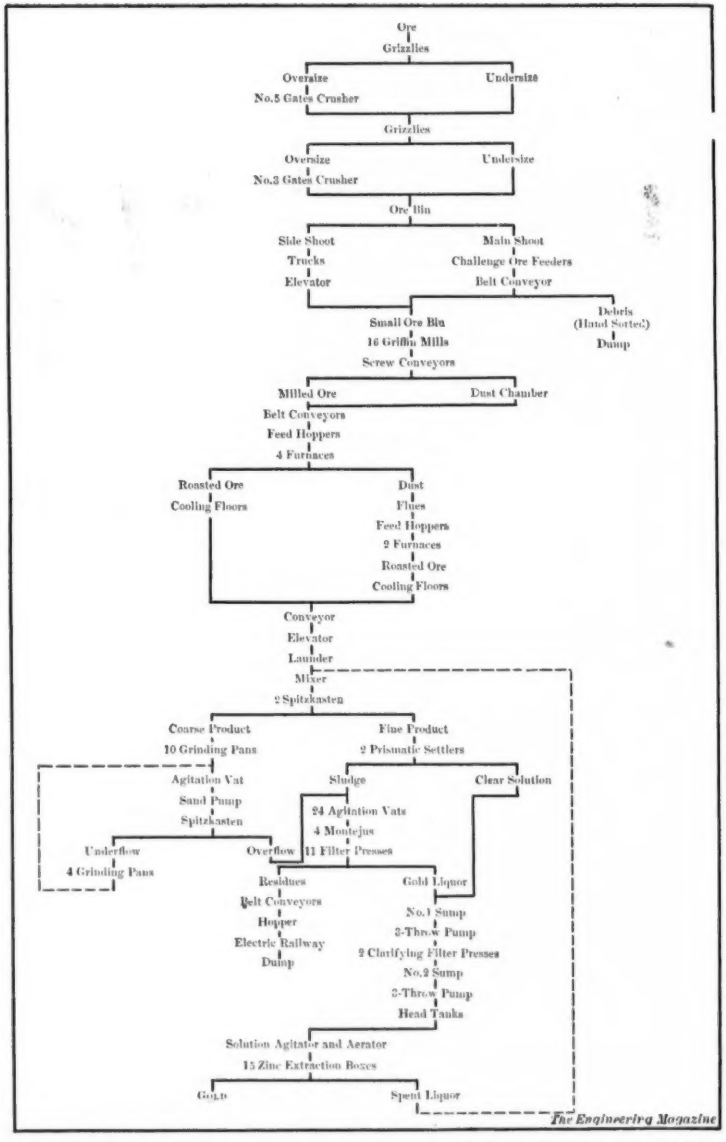
KRUPP FLINT MILLS AT THE GOLDEN HORSESHOE MINE.

Each mill is 16 feet 4 inches long by 4 feet in diameter and is run at 30 revolutions per minute. Each mill is charged with 5 tons of flints, requires 30 horse power to operate it, and grinds 30 tons of sand in 24 hours.

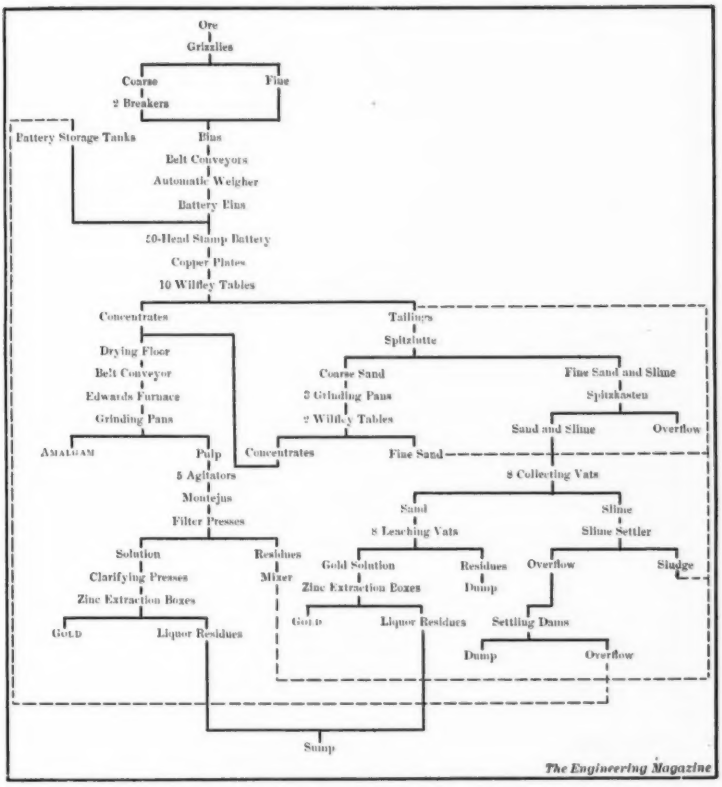
There are two main methods employed in cyaniding gold ores in West Australia. They may be described as, first, the method involving dry crushing, roasting, fine grinding to slime, cyaniding and filter pressing; and, second, the wet crushing, concentrating and cyaniding method. The details of these methods are illustrated on pages 604 and 605, in the flow sheets of two typical mines, the Great Boulder Perseverance, which employs the dry-crushing method, and the Sons of Gwalia, which crushes wet.

Dry Crushing.

The ore to be treated by the dry-crushing method is first crushed in Blake rock breakers, screened and dried in Howell-White revolving furnaces. It is then fed automatically into manganese-steel-lined Krupp or Griffin mills. Ball mills of the Krupp type are considered the most effective crushers. The plant on the Kalgurlie mine



FLOW SHEET OF A TYPICAL DRY-CRUSHING MILL, THE GREAT BOULDER PERSEVERANCE.



FLOW SHEET OF THE SONS OF GWALIA MILL, A TYPICAL WET-CRUSHING INSTALLATION.

is furnished with 9 No. 5 Krupp mills with a combined capacity of 11,000 tons per month. Each mill crushes about 45 tons to a 37-mesh screen size in 24 hours. The compressed steel balls used in the mills weigh 18 pounds each when new. Each mill is charged with balls of a total weight of 2,500 pounds. A new ball is added to each mill daily to compensate for wear and tear. The mills are run at a speed of 25 revolutions per minute and require 25 horse power to drive them. Milling in ball mills costs 75 cents per ton.

The Griffin mills are usually of No. 11 size. The crushing rolls are 15 inches in diameter and are suspended on a 6½-foot shaft, hung on a horizontal driving pulley running on ball bearings. This mill operates on a principle similar to that of the well-known Huntingdon

wet-crushing mill, but the Griffin mill has only one rotating crushing roll. The capacity of each mill is about 35 tons per 24 hours. As each machine requires 18 horse power to drive it, the daily output is about 2 tons per horse power. The crushing cost with Griffin mills is slightly higher than that of ball mills. The equipment of various dry-crushing plants is shown in the table below.

TABLE I. ALL-ROASTING PLANT EQUIPMENT.

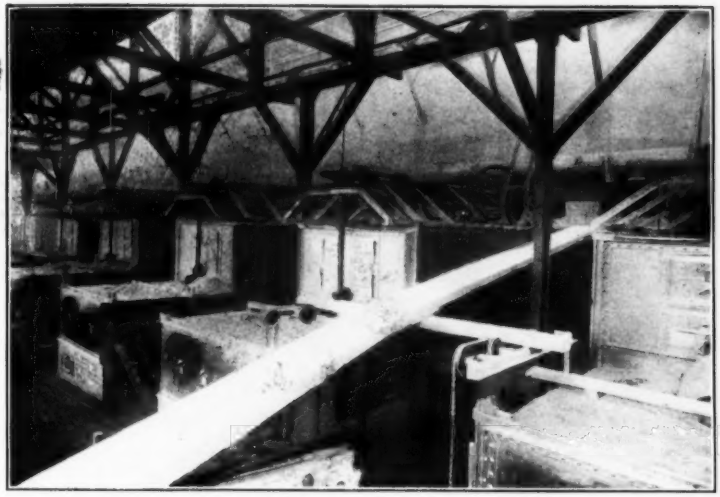
Mine.	Tonnage per Month.	Mills.	Furnaces.	Grinding Pans. Number.	Grinding Pans. Diameter, feet.	Treatment Costs per Ton.
Great Boulder.....	14,000	2 No. 8 Krupp. 12 30-inch Griffin	12 Edwards 8 Merton.	12	5	$2.74
Perseverance	16,000	16 No. 11 Griffin	6 Edwards-Perseverance	14	8	2.76
Kalgurlie	10,000	9 No. 5 Krupp.	15 Edwards.	15	5	2.88
South Kalgurlie.....	9,000	3 No. 8 Krupp.	8 Merton..	5	8	2.80
Associated	9,000	10 No. 5 Krupp.	18 Merton..	20	5	2.70
Associated North....	4,000	3 No. 5 Krupp.	5 Merton..	8	5	2.90

Dry-crushing mills, of course, make a large amount of dust. The mills on the Kalgurlie mine make 150 tons of dust per month, of which the gold content averages 15 pennyweights per ton. The mills are encased in sheet-iron covers which are connected with suction fans. The Kalgurlie mills are connected with three Sturtevant fans which draw the dust from the Krupp ball mills and carry it to a settling chamber, a frame building 72 feet by 14 feet by 23 feet in height. This dust chamber has a sloping or V-shaped floor divided into three compartments to facilitate cleaning. The dust is taken out monthly and the gold is recovered from it by cyaniding.

ROASTING.

Many types of roasting furnaces have been tried in West Australia, but they have all been abandoned in favor of the Merton and Edwards furnaces. These are both Australian inventions, and were developed for roasting ores for the chlorination process. They are now generally adopted throughout Australasia for roasting all classes of ore and their use is rapidly extending in the United States and Mexico.

The Merton roaster is a three-hearth machine-rabbled brick furnace. The hearths are horizontal and alternate ends are left open. The ore is stirred and automatically moved forward from the top to bottom hearth by revolving cast-iron rabbles. The rabbles on the



MERTON FURNACES, GREAT BOULDER MINE.

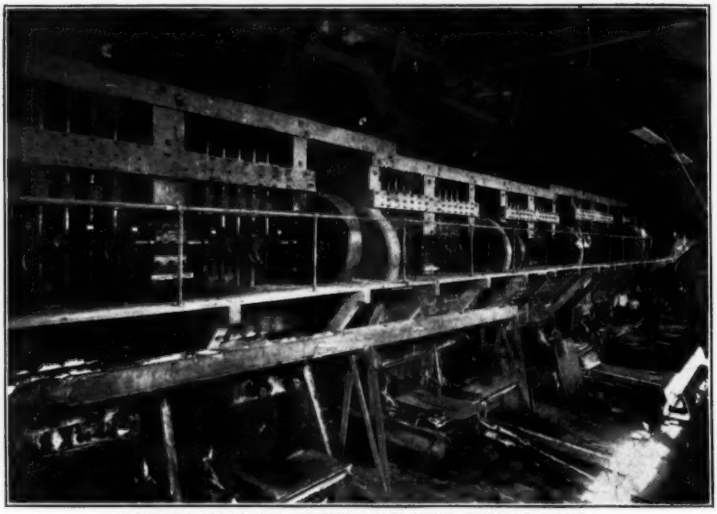
Eight furnaces each with an effective hearth area of 422 square feet. Each furnace roasts 25 tons per 24 hours. Sulphur reduced from 3.5 per cent to 0.05 per cent.

forward portion of the lower hearth, where the finishing or sweet roast is carried out, are water-cooled.

The Edwards roaster is used in two forms. The common type has the furnace fire box at one end. The Perseverance type, as developed at the Perseverance mine, is larger than the ordinary type, and, in addition to the end fire box, has two auxiliary fire boxes placed on each side of the hearth. This roaster is provided with automatic rabblers and a return cooling hearth which extends along the whole of the underside of the main roasting floor, or hearth. Details of the economy of the roasting furnaces are given in Table II.

TABLE II. ORE ROASTERS AT KALGOORLIE.

Mine.	Type.	Area of Hearth, Square Feet.	Average Tonnage per Day.	Percentage of Sulphur in Ore.	Cost of Roasting per Ton.
Kalgurlie	Edwards	665	23	4.2	$0.68
Perseverance	Edwards-Perseverance	1663	93	4.0	0.65
Great Boulder	Edwards	416	25	3.5	0.65
Associated Northern	Merton	630	22	5.0	0.61
South Kalgurlie	Merton	617	36	3.8	0.64
Associated	Merton	446	20	6.1	0.63



BATTERY CLEAN-UP AT THE LAKE VIEW CONSOLS MINE.

There are 75 head of stamps, each weighing 1,200 pounds and having a duty of 5½ tons of ore per day.

Fine Crushing

Fine crushing has been found essential to efficient cyaniding in West Australia. The free gold is often encased in other minerals and is only liberated so as to come in contact with the cyanide solutions when finely comminuted. The presence of calcium sulphate in the ores and mill water causes difficulty in emptying the cyanide vats unless the roasted ore is very finely pulverized. Fine crushing is done in tube mills similar to those long employed in the manufacture of cement, or in pans of the Wheeler type, which have been in favor with Australian mill men since the early gold mining days. The tube mills are from 14 to 18 feet in length and 3½ to 4½ feet in diameter. They are loaded with from 5,000 to 6,000 pounds of flints or other stones, and are driven at a speed of 30 revolutions per minute. Such mills require 20 horse power to operate them. They are lined with chilled iron plates which are often indented in various ways in order to receive a lining of flints set in cement. The crushing stones half fill the mills. The flints are obtained principally from France or the shores of the Baltic Sea and cost about $2 per ton on the gold fields. Each mill consumes about 2½ tons of flints per month, or about 1½ pounds per ton of ore milled. The chilled iron liners last six months.

The Wheeler grinding pans are generally from 5 to 8 feet in diameter and are driven at a speed of 50 to 70 revolutions per minute. The grinding weight of each pan is 2,500 pounds, and each machine requires 6½ horse power to drive it. In order to keep up the crushing efficiency of the pan as the shoes wear down, various methods of counterweighting are resorted to. The commonest method is to affix counterweights on the upper surface of the muller as wearing proceeds. In the Cobbe-Middleton type of pan the muller is fixed and the bottom of the pan is balanced by cross levers acting against the muller. In this way the crushing weight is kept constant during the whole run. The adjustment is automatically made by the levers as required. It is found that the grinding efficiency of pans is proportional to the circulation of the feed, and the circulation varies directly with the interspaces between the shoes. In consequence of this, the speed of the pans is increased as the shoes wear down to assist in keeping the tonnage uniform.

Advocates of pan grinding claim that the successful competition of wet-crushing mills in West Australia with those employing the dry-crushing and roasting methods has been made possible solely by the successful development of the pan. The mechanical details of the pan are still being improved, and it is probable that its efficiency will soon be further increased so that its output will be enlarged sufficiently to permit of a further reduction in grinding costs.

Wet Crushing.

Stamp batteries are chiefly used for wet crushing. The details of such batteries may be summarized as in Table III.

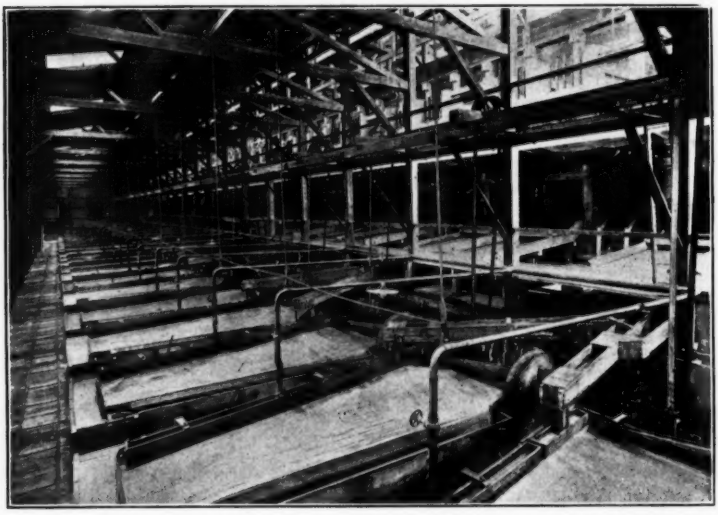
Table III. Stamp-Mill Details.

Mine.	Number of Stamps.	Monthly Tonnage.	Daily Tonnage per Stamp.	Weight of Stamps, Pounds.	Drop in Inches.	Number of Drops per Minute.
Ivanhoe	100	19,000	6.35	1,260	7.5	104
Golden Horseshoe	150	23,000	5.50	1,270	8.0	104
Oroya-Brownhill	50	11,000	7.35	1,100	7.75	108
Lake View Consols....	70	11,000	5.50	1,200	8.0	102

About 20 to 40 per cent of the gold in the ores is saved by battery and copper-plate amalgamation where the latter is practised Some of the batteries, like the Oroya-Brownhill, do not use copper-plate amalgamation.

The crushed ore after passing from the batteries and settling in hydraulic settlers is run over concentrating tables of the Wilfley type. One table is used to every five stamps. The tailings from the

tables are pumped to hydraulic classifiers and the coarse sands are run to tube mills and thence to the sump. The fine sands are classified and run over concentrating tables and the fines carried to the sump.



WILFLEY TABLES AT THE IVANHOE MINES, WITH STAMP MILL IN THE BACKGROUND.

Experiments are being made at some of the plants using the "wet-sliming" process to improve the crushing efficiency by stage grinding in pans with final sliming in tube mills. The results obtained at present are conflicting. Some metallurgists prefer to crush in stages in pans while others proclaim the superiority of the tube mills. It would appear that the differences in the results recorded are due more to variations in the nature of the ores crushed than to differences of efficiency in the crushers. The final results of the tests will probably show that the greatest efficiency, in most cases, will be given by happy combinations of batteries, pans and tube mills adapted to the particular requirements of the ores to be treated.

CYANIDING.

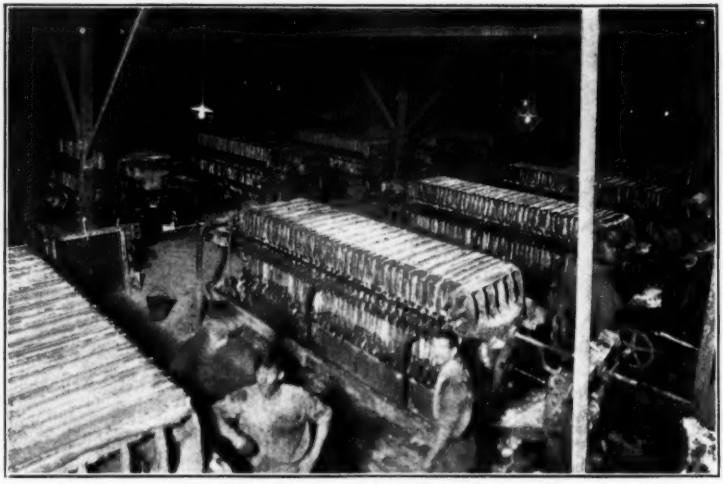
The "continuous" process of cyaniding is the one principally practiced in West Australia today. The finely ground ore is kept in contact with the cyanide solution throughout the treatment process. In the wet-crushing plants, the battery water carries from 0.003 to 0.007 per cent of potassium cyanide in solution. The only fresh water used while treating the ore is in washing the filter-press cakes.

The method of cyaniding at the all-roasting dry-crushing plants is substantially as follows: The ore is dry-crushed in ball or Griffin mills, roasted in Merton or Edwards furnaces, fine crushed in Wheeler pans, agitated with cyanide solution in vats and extracted from the solution in filter presses. The gold is precipitated from the cyanide solutions in zinc boxes on zinc shavings. Zinc dust precipitation, as practised in some of the American mills, has not proved successful in West Australia. The zinc is scrubbed through a 20-mesh screen, calcined, and smelted in Martin tilting furnaces with a flux consisting of 25 per cent fused borax and 10 per cent fine quartz sand. An average assay of the bullion thus produced gives 70 per cent fine gold, 26 per cent silver and 4 per cent base metal. Experiments have shown that the all-roasting plants are cheaper to operate than the wet-crushing plants and they are usually more efficient.

CYANIDE AGITATORS AT THE GOLDEN HORSESHOE MINE.

There are 22 vats, each 22 feet diameter by 8 feet deep, provided with mechanical agitators driven at 6 revolutions per minute. Each vat holds 54 tons of pulp. Agitation is carried on for 20 hours with a 0.06 per cent solution of sodium cyanide.

The wet-crushing process may be illustrated by describing a typical plant. At the Golden Horseshoe mine the ore is crushed in breakers and automatically fed to a 150-stamp mill. The mill pulp is run into a set of 10 hydraulic classifiers. The coarse sands from the classifiers are distributed over 12 Wilfley tables and the fine sands over 11 tables. The slime overflows to settlers. The products of



FILTER PRESSES AT LAKE VIEW CONSOLS MINE.

Each press holds 5 tons of slime. They are filled and washed by 3-throw belt-driven geared plunger pumps.

the Wilfleys are distributed thus: The concentrates go to the roasters, the middlings are re-concentrated and the fine sand and slime are pumped to sand traps. The underflow from these traps is dried, crushed in tube mills and sent to the sumps. The slimes are finally charged into agitation vats holding between 50 and 60 tons and agitated for a period of 18 to 30 hours with a solution of cyanide of potassium of 0.06 per cent strength. The recovery amounts to 88.4 per cent of the assay value of the ore. The total milling and cyaniding cost is $3 per ton.

Bromo-Cyaniding.

In the majority of the mills potassium cyanide is used exclusively. In a few plants bromide of potassium is added to the cyanide of potassium solutions. This practise was introduced by Dr. Diehl to treat the Kalgoorlie tellurides. The dissolving solution, when the Diehl process is used, is made in accordance with the equation

$$2KBr+KBrO_3+3K(CN)+3H_2SO_4=3Br(CN)+3K_2SO_4+3H_2O.$$

The reaction which occurs in the treatment vats is believed to be in conformity with the equation

$$Br(CN)+3K(CN)+2Au=2KAu(CN)_2+KBr.$$

The bromine is obtained from Germany in the form of potassium bromide containing from 40 to 44 per cent of bromide, or potassium

bromate with 20 to 22 per cent of bromine. When a vat is charged with slime a bromide solution is made up of 50 pounds of sulphuric acid, 20 pounds of potassium cyanide and 39 pounds of mixed bromine salts. The potassium cyanide used has a strength of 93 per cent and the sulphuric acid 63 per cent. The charge costs about $20 and is sufficient for solution in 200 gallons of water. Some of the ores treated by bromo-cyaniding yield 95 per cent of their gold content. A plant at the Hannan's Star mine, Kalgoorlie, successfully treats an ore averaging only 10 pennyweights of gold per ton. The process is simple, but it requires attention to carry it out successfully. For this reason it has not yet come into extensive use.

Filtration.

The introduction of fine grinding preparatory to cyaniding necessitated improved methods of filtration for separating the auriferous solution from the sand. Very important contributions to the improvement of cyaniding practice have been made in this respect by metallurgists in West Australia. When the cyanide process was first introduced in West Australia the auriferous solution was drawn from the vats by the old decanting methods which are used extensively in South Africa. These were found to be too slow at Kalgoorlie, and experiments were made at the Golden Horseshoe mine with filter presses similar to those used in sugar refineries. Excellent results were obtained and filter pressing immediately displaced decantation in all the local plants.

Filter Presses.

The filter press is designed to separate the finest particles of matter suspended in a solution from the liquid by mechanical means. It consists, in its simplest form, of three rectangular frames clamped tightly together. Two of the frames are provided with corrugated iron plates which completely occupy their centers, like a picture in its frame. The corrugated plates are covered on either side with a punched iron screen, around which a filtering cloth is wrapped. The central frame is open and has no filter cloth around it. If a mixture of slime and water is forced into the center or open frame through a lateral orifice, the liquid will escape through the filter cloth and through the punched iron screens of the adjacent frames. The water will then pass along the surfaces of the corrugated iron sheets to lateral draw-offs connected with a suction pump. Whenever desirable, a current of air or water can be forced through the filter in the reverse direction to the travel of the cyanide solution. Such reverse

currents would wash dry or blow off the fine particles of slime adhering to the filter cloths. The filter frames have projecting lugs through which holes are bored for charging the press with pulp, air or wash water, and to carry off the filtered solution. The ordinary press is furnished with from 30 to 60 frames.

The presses are operated as follows: Pulp is forced into each press by pumps or compressed air and spreads over the filter cloths while air and the solution pass through, leaving a cake of slime on the cloth. This operation takes from 10 to 20 minutes. The slime cakes thus formed are washed by forcing wash water through the press at a pressure of about 80 pounds per square inch for 20 minutes. Afterwards a current of air is forced into the frames in the same direction to dry the slime. This air displaces about half the moisture absorbed by the slime. The presses are then opened by relaxing the large screw clamps at the head of each machine. The slime cakes are scraped off the filter cloths into trucks or belt conveyors below the presses. The filter cloths are cleaned, and the machines are again tightly clamped to be ready for fresh charges. The whole cycle of charging, filtering, washing, drying, emptying, cleaning and re-clamping the presses occupies about an hour.

There are 18 filter presses, each having 52 frames, and 900 square feet of filtering surface in daily operation on the Golden Horseshoe mine. Each press has a capacity of 5 tons of raw slime or 6 tons of concentrates per day. Five men charge and discharge 45 presses per 8-hour shift. The solutions from the presses are collected in sumps and subsequently pumped through two clarifying presses before going to the storage vats preparatory to entering the zinc precipitating boxes. Eight presses at the Ivanhoe mine treat 23,000 tons of pulp monthly at a cost of 15 cents per ton. At other mines two men using two presses handle seven charges, or 25 tons of slime in eight hours.

The Moore Filter.

The filter press has been successfully introduced into cyanide plants in the Transvaal, Rhodesia, Mexico and Canada. It is very successful at the Homestake mill in Dakota, but in some of the Western mills trouble is experienced in getting proper skilled labor to operate it. This has resulted in the invention of presses of greater simplicity.

The Moore filter is a development of the filter press. Instead of the filter frames being small in area and fixed in a machine, Moore made them of large dimensions and suspended them in a basket from

an overhead traveling crane so that they can be moved to and from a series of vats. A typical Moore filter has 49 filter frames, or leaves, 16 feet long and 5 feet wide, with a combined filtering area of nearly 7,800 square feet, hung in a basket and suspended from an electric crane. Each filter leaf is formed of canvas doubled over a frame of Oregon fir. In the bottom edge of each leaf, a ¾-inch channel iron is screwed to act as a launder for the in-filtered solution. Each leaf contains a 1-inch vertical suction pipe connecting the iron launder with a pump. Each leaf resembles the leaves in a press excepting in the dimensions of the frames and the materials used in their construction. The basket is about 16 feet square, and is hung from the crane by four endless 1-inch pitch chains. It is raised or lowered by a 10 horse-power electric motor. The maximum load of the full basket is 35 tons. The crane travels along a track of 60-pound steel T-rails.

This filter is operated by lowering the basket into a vat full of pulp until the leaves are submerged. The suction pump on top of the basket is started and draws the auriferous liquor through the canvas and discharges it into storage tanks. Suction is continued with intermittent agitation in the vat until a ¾-inch coat of slime forms on the canvas. Then the basket is raised and carried over to a washing vat. After washing the basket is raised and carried to a discharge hopper. The suction is continued until a large amount of moisture is removed from the slime cakes. Air under a pressure of 35 pounds per square inch is finally turned on in place of the suction. This discharges about 85 per cent of the slime into the hopper. The balance is cleaned off by hand. This cycle of operations occupies about 10 hours. Eighteen tons of slime are handled by the filter each 10-hour shift.

The Butters-Cassel Filter.

Cassel inverted the Moore procedure. The Cassel filter, as modified by Butters, is simply a rectangular vat with fixed filter leaves. The leaves are similar to those of the Moore filter in size, but they are made of a frame of iron piping covered with cocoa matting which in its turn is covered with canvas. This makes a strong, straight-filtering mattress. From 50 to 150 leaves are set in a vat. The operation of the filter is similar to that of other suction filters. The liquid is drawn through the leaves by suction pumps and the filter vat is charged and discharged by centrifugal pumps. Cassel filters are handling 4,000 tons of slime monthly at the Lake View Consols mine, Kalgoorlie, and a plant of similar capacity has just

been erected on the Gwalia South mine. Filters of this type are displacing the filter press on many West Australian mines. They require less labor to operate them than the presses, are cheap in construction and have large capacity. Large numbers of small steel fixed-leaf filters are being made by machinery houses. They will, doubtless, be employed in many of the new cyanide works where large filtering capacity is not required.

The Ridgway Filter.

A new type of filter, invented by the engineer of the Great Boulder mine, has been successfully developed at Kalgoorlie. It consists of a number of horizontal filter leaves suspended from a vertical spindle in the center of a cylindrical vat. Pipes communicating with each filter frame are attached to the central spindle. The vat is divided into three compartments. One compartment is used for pulp, one for wash water and one for discharging the slime cakes. The filters are revolved around the spindle at a speed which allows each filter frame to remain 13 seconds in the pulp vat, 7 seconds on the elevated bridge while passing from the pulp to wash vats, 30 seconds in the washing vat, 7 seconds while lifting and drying and 3 seconds while the blowing pressure is on over the discharging vat. The complete revolution thus takes about a minute.

There are usually 12 filter frames in each machine with a filtering area of 144 square inches each. The filter deals with 50 tons of dry slime per day. The machine works automatically. A series of 10 treating 500 tons of slime per day at the Great Boulder mine requires the attendance of only one man per shift. The extraction by the Ridgway filter is better than that by any other type and the treatment costs are lower. The efficiency of the filter is greatly promoted by the comparative thinness of the slime cake. It is less than ⅛ inch in thickness as compared with those of several times that thickness in other filters. The thinness of the cake permits cleaner washing and, consequently, a better gold extraction.

Treatment of Concentrates.

The proper treatment of concentrates is becoming an important question with West Australian mining companies. The gold ores on most of the fields become refractory below the water level and concentration has to be resorted to. When only small quantities are produced they can be satisfactorily disposed of to custom smelters. When, however, the output is large, the ores must be dealt with at

the mine. The method of treatment employed at a few typical mines will indicate the general lines of treatment in West Australia.

The concentrates at the Oroya-Brownhill mine carry a large amount of mineralized matter and average 35 per cent sulphur, 0.5 to 0.6 per cent tellurium and about 42 per cent of the total gold contents of the ore. They are saved on Wilfley tables and roasted in Merton furnaces. Those furnaces roast 600 tons per month, reducing the sulphur content to 0.2 per cent as sulphide. The roasted material is ground fine in two sets of pans. The first set of pans is fed with mercury three times a day. About 30 per cent of the gold is saved by amalgamation. The second set of pans is used for fine grinding only. They receive the coarse part of the overflow from the first set. The united overflows are sent to vats, and, after being cyanided for 100 hours, are passed through filter presses.

The Redhill concentrates are roasted in Edwards furnaces by heat generated by their own sulphur contents. Assays show their composition to be 36.2 per cent iron, 34.3 per cent sulphur, 0.5 per cent nickel, 4.2 per cent silica, 8.4 per cent alkalies and 14.9 per cent oxygen, with free gold in scaly pieces. There are usually present also from 3 to 4 per cent of soluble sulphates and chlorides. The presence of the latter is due to the salts in the mine water used in milling the ore.

The Bellevue concentrates are also very refractory. They are roasted and ground in pans without mercury. The sulphates in the water cause a large amount of scale to collect in the pans. After a month's run the hard scale assays as high as 250 ounces of gold per ton. The overflow from the pans goes to Wilfley tables. These take out any unroasted concentrates which escape from the furnaces and save scale from the pans. It is found, also, that gypsum crystals are deposited in thick net-like bunches on the riffles attached to the tables, with the axes of the crystals at right angles to the surfaces of attachment. They thus form a series of cross riffles which very effectively save the finest gold particles. This calcium product when collected averages over 5 ounces of gold per ton. The finely ground material from the pans is cyanided and an average gold extraction of 90 per cent is obtained. The scale is sold to the customs smelters.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel.

V. THE IMPORTANCE OF COMPARATIVE ELEMENTS AND HOW THEY ARE APPORTIONED TO PRODUCTION.

Mr. Knoeppel's series, which began in the October, 1908, number of THE ENGINEERING MAGAZINE, has already dealt with the simple elements of the problem of foundry costing, the importance of correct burden apportionment, and the enumeration and classification of the elements entering into production costs. In the present instalment he discusses the apportionment of the various elements to product. Next month he will show how the principles of cost apportionment enunciated here are applied to various classes of foundries.—THE EDITORS.

STARTING with two definitions, first, that "success is the accomplishment of some particular ambition or undertaking," and second, that "failure is lack of accomplishment," let us endeavor to ascertain, if we can, upon what an accomplishment in foundry work depends—a knowledge which should interest those who are striving for results in the way of greater efficiency.

In the first place, let us keep in view this fact:—*nothing is large or small except by comparison.* When a man speaks of the judgment of another as being "sound," he has compared this man's judgment or his success either with his own or with that of other men of his acquaintance. When a man is called upon to decide regarding a policy, he compares the advisability of carrying it out along certain lines with that of carrying it out along opposite lines. When a man is called upon to decide between the choice of two vocations, he first compares one with the other. A lawyer in summing up compares his arguments with those of his legal opponent, while the jury in turn compare the arguments advanced by the opposing lawyers. Before a man becomes a member of a church, he first compares creeds and beliefs; before a man designs a machine, he compares the different ways he could construct it; before a man builds a house, he compares different styles of architecture—in fact, comparison seems to be a basic element of vastly greater importance than is at first apparent.

It is no doubt evident to all that nothing is done, no move ever made, except through the instrumentality of an *action* of some sort, and that no one acts one way or another without first deciding as to

the course to pursue—*conclusion.* Looking at comparison, then, as a basic element, it can be seen that after a comparison has been made but *before* a conclusion can be reached and action taken, it is necessary for something to bring out the good features and eliminate the bad ones—to affirm or to deny—this something being a mental process—Reason. Accomplishment, then, is an effect—the result of an efficient action, based on a logical reasoning applied to a thorough and complete knowledge of comparative elements. If this is true, it follows that if our elements are incomplete or faulty, the reasoning and conclusions are bound to be illogical and the action a failure or at least inefficient—in fact it is this lack of sufficient comparative data that is responsible for so much of the inefficiency that Mr. Harrington Emerson criticizes so ably in the series now running in this magazine.

All this means a great deal to the business world, being of special significance to the foundry industry; for in the conduct of a foundry business, success is dependent upon the course pursued by its management—action—which to result in accomplishment depends upon the reasoning applied to comparative elements—analysis in other words. The lesson is plain. *Facilitate analysis by concentrating every effort toward making comparisons efficient.* Intelligent action—accomplishment—success will follow as a natural result.

The preceding paper gave a suggestive outline of the comparative elements peculiar to the usual foundry enterprise; this paper will take these elements, which serve a two-fold purpose—first, the finding of costs, second, the facilitating of analysis—and reclassify them so that the exposition will not only be more comprehensive and efficient but correctly apportioned to production as well.

The conducting of a foundry business involves two things—the making or production of castings, and the sale or disposition of the castings produced—the shop being responsible for the making or production, and the second element being a purely commercial transaction about which the shop has very little if anything to do, exercising no direct influence over the executive control and administration of the business; consequently in justice to both interests we must consider the following as being the principal divisions of the grand total of the elements entering into cost of production:—

1.—Shop Cost—that is, the cost of making the product.

2.—Commercial Cost—that is, the cost of administering the business and disposing of production.

Shop Cost is found to be made up of two kinds of costs which we will term "Direct Cost," including those items which can be charged direct to specific production, such as iron, moulding, etc.,

and "Indirect Cost," including those items which cannot be applied direct, such as sand, supplies, supervision, laborers—the elements entering into Direct Cost being classed under the headings or subdivisions of "Direct Materials," such as pig and scrap irons, etc., and "Direct Labor," such as moulding and core making.

The elements which go to make up Indirect Cost are also of two kinds—those which have a tendency to increase or decrease as the volume of product increases or decreases, and those which do not seem to have this tendency; consequently it is necessary to observe this distinction in our calculations, and we will therefore divide "Indirect Cost" into (1), Tonnage Charge, and (2), Foundry Charge, the first being applied to product as an additional charge to the amount which it receives through Direct Material, the second being applied to product on the basis of Direct (or Productive) Labor.

Commercial Cost, defined above as the cost to administer the business and dispose of product, should be divided into "Administrative," including all items of expense which enter into the successful management of the business, such as executive and office salaries, office expense, supplies, etc., and "Selling," including all expenses made necessary because of the marketing of the product of the shops, such as salesmen's salaries and expenses, advertising, etc.

From this it will be seen that we have six subdivisions of costs common to a majority of foundries:—

DIRECT MATERIALS
DIRECT LABOR
TONNAGE CHARGE
FOUNDRY CHARGE
ADMINISTRATIVE
SELLING

These control the numberless details peculiar to them, the subdivisions being in turn controlled by others:—

DIRECT LABOR, DIRECT MATERIAL } making DIRECT COST.
FOUNDRY CHARGE, TONNAGE CHARGE } making INDIRECT COST.
ADMINISTRATIVE, SELLING } making COMMERCIAL COST.

Commercial Cost combined with Shop Cost (Direct and Indirect Cost) make "Total Cost"; so that no matter what the executive

wants to scrutinize, whether the amount of sand or chaplets used or the cost to sell the product—the cost to make the castings or the details regarding the shop expenses—he has a means of getting at what he wants to know *automatically*, all being arranged and classified for immediate reference. It is therefore necessary to reclassify the various cost accounts previously shown, according to the six subdivisions; Charts 1, 2 and 3 show what each sub-division comprises, Chart 4 being an exposition of how they are merged into Total Cost and apportioned to product.

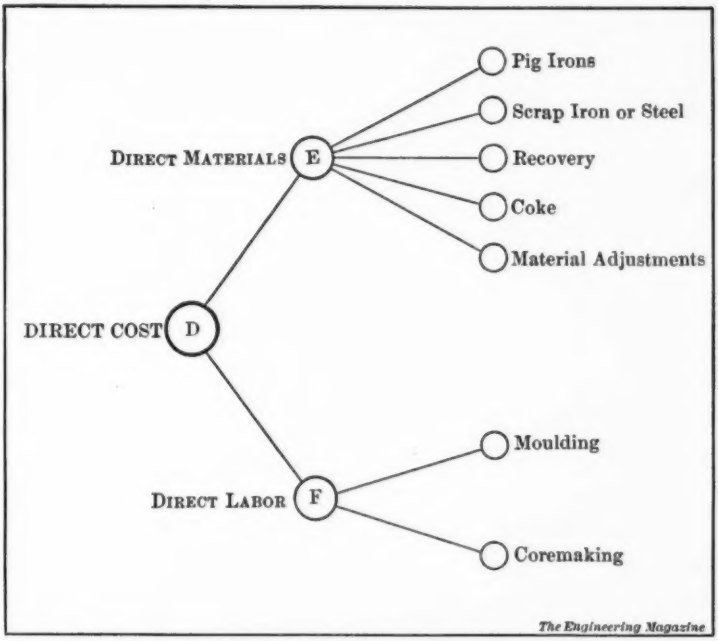


CHART I. THE ELEMENTS ENTERING INTO DIRECT COST.

Regarding the suggested apportionment, it will be seen that Direct Material and Direct Labor, on account of their nature, are *direct* charges to production and are therefore easily disposed of in costing. In Indirect Cost we have an element not capable of being handled so easily, for while there is absolutely no question regarding the advisability of apportioning this element, part to product on the basis of tonnage and part on the basis of Direct Labor, there may be considerable question regarding the advisability of apportioning the various elements which made up this sub-division according to the manner

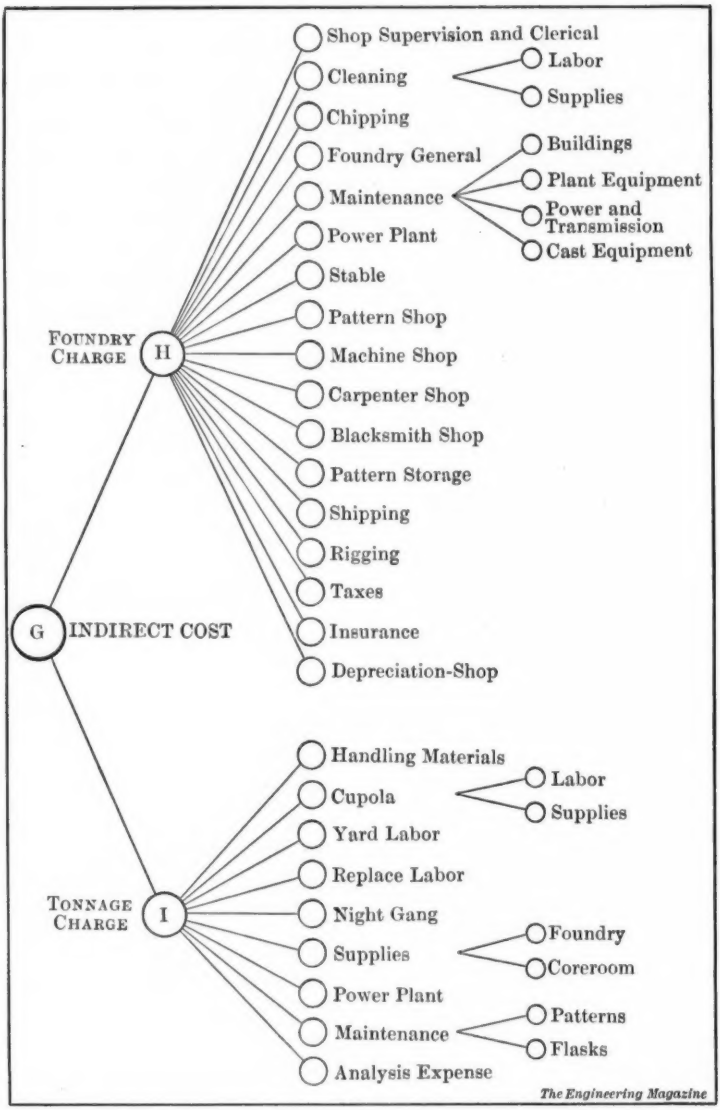


CHART 2. THE ELEMENTS ENTERING INTO INDIRECT COST.

outlined in Chart 2. In determining to which class any item of Indirect Cost belongs, the relation of each one to the tonnage produced must be given consideration. If the tendency is for the cost of an item to increase or decrease as the volume of the product increases or decreases, the item is a charge to production on the basis of *tonnage*. If this is not the case, however, the apportionment must be made on the basis of Direct Labor.

Take for instance the item "Handling Material." Here we have an element that will increase or decrease with the tonnage produced, not proportionately perhaps but to some extent at any rate, while the increased tonnage which necessitated this extra handling cost might have been accompanied by the expenditure of about the same amount of labor, owing perhaps to a different line of work. This reasoning also applies to Yard and Cupola Labor. Regarding Replace Labor, it is evident, though it does not always follow, that the greater the total of production the greater will be the labor expended to replace castings condemned in the foundry; for it is natural to expect that more castings will be lost and replaced when the production is 500,000 pounds monthly than when it is only 200,000. From this it seems proper to include Handling, Yard, Cupola and Replace Labor in the TONNAGE CHARGE section.

A foundry starting with a tonnage of 10 tons daily will find that it will have to add more men to the force who take out the work at night when the tonnage increases to 20 tons per day, so that it is proper to class the item Night Gang as a tonnage expense along with Foundry, Core Room and Cupola Supplies which tend to increase as production increases, while to this same class can be added Maintenance of Flasks and Patterns as these expenditures will be greater with a larger production than when the production is such as does not call into play so many flasks and patterns. As the power used is proportionate to the run of the cupola, the proper amount of the Power Plant charge should be included in the tonnage item along with Analysis Expense, which is included in this section not so much because the expense is likely to increase as the production increases (depending of course on the variety of the work) but because of the fact that analysis is directly related to metal produced. Briefly reviewing, it will be seen upon consideration that the items mentioned may increase in proportion, or faster, or not as fast, as the increase in production; but the tendency is to increase nevertheless, while the increase in the production may be the result of about the same amount of direct labor, although this increase could be accompanied by a greater relative increase or even a decrease in this direct labor, all of

which seems to indicate that apportionment of the items mentioned to the production on the basis of tonnage is perfectly logical.

Let us consider for a moment the suggested apportionment to "DIRECT LABOR." If the items have a tendency to increase in cost as the amount of direct labor increases; or if, on the other hand, there is no relation between the two, and no relation between the cost of the items and the tonnage produced, then they are correctly shown in the exposition. Take for instance Shop Supervision and Clerical. It stands to reason that the more producers there are at work the greater will be the need for supervision and clerical work, while with fewer producers less will be required, although the cost per dollar of direct labor will be greatest when a minimum number of producers are at work, because of the fact that supervision and clerical work cannot decrease in proportion to the decrease in the amount of direct labor expended; they decrease as the amount of direct labor increases until a point is reached when more supervision is required; and as consideration will show that the same expenditure of direct labor might result in a large production one week and a small one in the week following, it is evident that the item mentioned is more nearly proportionate to labor expended than to tonnage produced.

The item of Labor and Supplies for the Cleaning Room, as well as Chipping, has been included in the expense apportionable to direct labor, although the labor of cleaning and chipping can be charged direct to production if the foundryman so chooses. It was included as shown for the following reasons. Consider for instance a small complicated casting which might only weigh 500 pounds, taking the entire time of a moulder for a day, as against a large plain casting made in the same time; it is more than likely that the cleaning cost will be about the same in both cases, while on the other hand a small, plain, easy-to-make casting could be cleaned quickly, while a large, complicated, difficult-to-make casting would take considerable time for this operation. It seems after watching the cleaning operation that it bears a close relation to direct labor, comparing the making and cleaning of complicated with complicated work and plain with plain work, although it does not follow from this statement that the relation is always proportionate. On account of this relation, however, and because of the fact that the entire cost of cleaning and chipping could not be applied to product direct without considerable detail work, necessitating the charging of a part of the cost to DIRECT LABOR and the balance to FOUNDRY CHARGE, it has been included as a labor apportionment item, not only for the sake of simplicity but because in this way the executive is provided with a logical control of this

expense. I know of an instance where by keeping separate the entire cost of the cleaning, the executive was enabled to reduce this expense, through comparing it with his other elements as well as with the same item for previous periods, which would not have been possible had part of the cleaning cost been in expense and part divided as DIRECT LABOR, in small amounts, among the various jobs.

As to Foundry General, it may be said that this expenditure is largely dependent upon the number of producers at work, regardless of the tonnage produced, although there might be times when it would be more nearly proportionate to tonnage than to labor—as for instance in cases where, because of change in work, about the same amount of labor might produce a considerably larger tonnage, necessitating additional shop labor. In most cases, however, the tendency is for this cost to increase or decrease with the increase or decrease in direct labor for which reason it has been classed as a FOUNDRY CHARGE expense. Regarding the Maintenance items, it should be evident that keeping the real estate and buildings, the equipment of the plant, etc., in proper condition really has nothing to do with the amount of the tonnage produced by the shops. Repairs might be the lowest when production was the highest, or *vice versa*; in fact, deterioration might be greatest when there was no production at all. As a matter of fact, they might not bear much relation to the amount of direct labor, but as they are not items which increase or decrease with the tonnage produced, we must include them in the FOUNDRY CHARGE section, applying them to production on the basis of labor. As we arranged to charge a certain proportion of the power-plant cost to tonnage, we must include the balance in the FOUNDRY CHARGE section along with the cost of various departments, stable, pattern shop, machine shop, carpenter shop, blacksmith shop, pattern storage, which must be conducted regardless of whether the amount of tonnage produced is 5 tons or 20 tons daily, although these costs would very likely increase with the increase in the force of producers.

Upon first consideration, it might seem as if Shipping belonged to the TONNAGE CHARGE section, because of the fact that the shipping expense is sometimes greater with a large amount of tonnage than with a small amount. A moment's reflection will show, however, that it is possible for a large amount of labor to turn out, instead of large tonnage, a large production in the count of pieces, necessitating considerable shipping expense for gathering, tagging and shipping, so that in the strictest sense this term is proportionate to neither tonnage nor labor, and not being a tonnage charge it must be placed in the labor section. As regards Rigging it follows that the nature of the

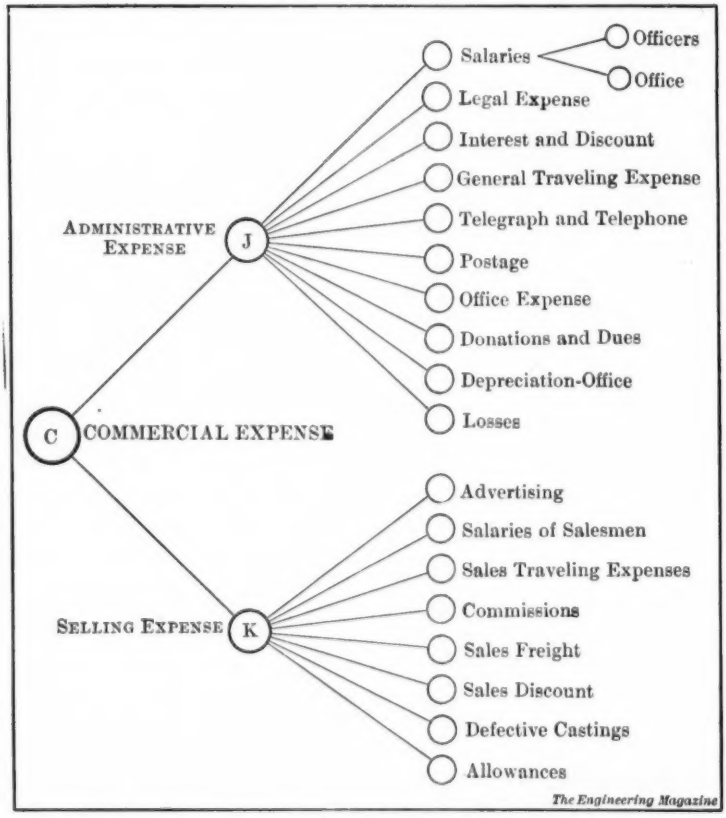


CHART 3. THE ELEMENTS ENTERING INTO COMMERCIAL COST.

work being done, etc., really governs this expenditure, and that it might be greatest with a small tonnage or when the number of producers was not large, or *vice versa*, so that like Shipping, this item really belongs in neither section, for which reason it has been placed in the labor section as a memorandum charge only, in order that Total Cost may show the total expenditure for rigging for comparative and estimating purposes, while the items Taxes, Insurance and Depreciation, bearing as they do no relation to the increase in the tonnage produced, are apportionable, because of this fact, to DIRECT LABOR.

In considering the handling of Commercial Cost, all will agree that some means must be provided for taking care of it—that it is not

a cost capable of direct charging, and must therefore be classed with the apportionable items; and that in our search for a basis on which apportionment can be made, we can find only two elements—Production and Sales. On the latter basis, the ratio between the amount of Commercial Cost and the amount of the sales is ascertained and the selling price of the different orders multiplied by the resultant percentage, the product being added to Shop Cost. Another method is to deduct monthly, from the revenue from sales, the Shop Cost of the sales, the difference being gross profit—the amount of net profit being ascertained by deducting the commercial expenses from the gross profits. There is no question that (as before stated) the difference between production and commercial costs is of sufficient importance to warrant us in strictly observing this distinction.

An analysis of the items which go to make up the administrative and selling expenses will show that the expenditures have to do with the past, present, and future—that some are concerned with sales, others with production or production and sales combined, and still others with neither production nor sales. The item "Donations and Dues," for instance, has nothing to do with production or sales, the past or the future. Some of the items in the selling expense division like "Advertising and Salesmen's Salaries" are concerned with getting future production—others with what was done in the past, like "Commissions" and "Allowances." Items like "Telephone and Telegrams," "Postage" and "Office Expenses" are likely to be as much concerned with what is being produced as with the work of making sales or taking care of the sales that have been made. The past cannot absorb that which belongs to the past; we cannot hold the items belonging to the future until they shall be applied; it would be difficult to apportion to sales those items which belong to sales, and to production those which belong to production. It therefore seems, after briefly analyzing the make-up of the commercial expenses, that it would be best to make each month's production stand on its own feet by making it absorb the entire expense for the period, in this way converting all of the expenditures of a period into an asset; for on the assumption that we ship none of the castings we might have made, at the end of the period they would appear in our resources as "Manufactured Castings" at an amount equal to the cost of the material, labor, and expenses. On a basis of commercial expense apportionment to sales, a month's production would be charged to inventory at shop cost, and assuming that there were no sales from which to deduct the commercial expenses, these expenses would have to be considered as a loss. A profit or a loss should show *after* sales are made, not *before*, as the

difference between the selling prices of what is sold and the cost of product, which is the result when inventory is charged with commercial as well as shop cost.

A good casting is the result of a moulding process which involves the making and setting of cores—two distinct operations. A completed engine is the result of an assembling process which involves the machining of the parts—two distinct operations. Viewed in the light of the illustrations just cited, production is the result of a manufacturing process which involves a commercial process—the administration of the business and the disposition of what is produced, without which production would be impossible—two distinct operations. Manufacturing expenses bear a direct relation to production —the commercial expenses, an indirect; but *production* nevertheless, is the underlying element with which any enterprise is concerned.

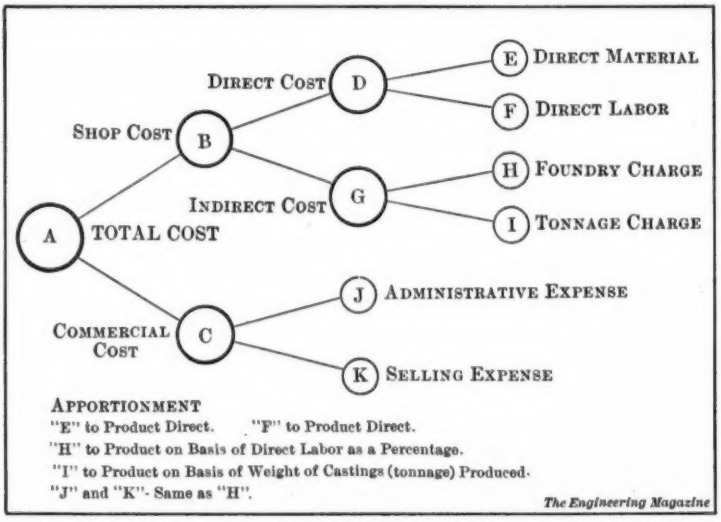


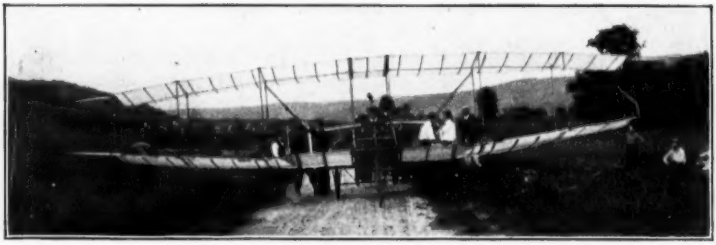
CHART 4. THE MAIN ELEMENTS OF PRODUCTION COSTS AND THEIR APPORTIONMENT TO PRODUCT.

We can apportion "Commercial Cost" to production in three ways —on tonnage, direct labor or shop cost. The method to choose should be one which will be fair to the company, the shop management, and the workmen, and which will also point out to the executive what he should know to supervise and direct intelligently. This can best be accomplished by using direct labor as our basis for pro-rating; but as opinions count for nothing unless backed by some substantial evi-

dence, let us see if there is any logic in this assertion. In the first place, all will agree that direct labor is the true investment in any enterprise, for the reason that the more we expend for labor that actually produces something, the greater should be the amount produced, regardless of how much material was used or the amount of the indirect expenses. It is also evident that the greater the number of producers at work the lower will be the relative overhead expenses or "burden," while these will increase as the number of producers decreases, so that the relation of burden costs to the amount expended for direct labor is too important to be lost sight of—the ratio between the two being an inverse one. If a workman produces a large amount for a low labor cost, his production should absorb a *lower proportion of the burden cost* than the one who produces the same amount at a higher labor cost or a lower production at a high labor cost. If this is logical, then it is right for us to make the product of each workman absorb the burden *in proportion to the amount paid him for direct labor.* In this way each man will stand on his own feet, for the one having the greatest production will absorb the lowest burden cost, and *vice versa.*

The result to the management is this—work costing the most in direct labor will cost the most in burden, which is as it should be for furnishing the best means for accurate price determining as well as a basis for determining the efficiency of the shop management and the workmen. A customer should pay the most money for castings costing in direct labor the most to produce. If a mistake has been made in quoting it will show in the form of a much smaller profit than anticipated, or perhaps in a loss, or in the form of an excessive profit —an over-estimation. If no mistake is made in quoting, however, and the amount of direct labor greatly exceeds what it should have been, it will not only show in the form of an increased direct-labor cost but in the increased amount of burden absorbed, with the result that the total cost will be in excess of the price received, showing a *loss* for the executive to take up with the shop.

Profits or losses will be what was made or lost; prices will be based on true costs; the product of a workman will bear no more or no less of the burden than its direct labor makes it stand; fluctuations will be noticed, as burden costs will rise or fall with the rise or fall in direct labor, so that after due consideration I am of the firm opinion that the points brought out logically point to "Commercial Cost" apportionment to production on the basis of "Direct Labor," as being right and proper.



THE "JUNE BUG" READY FOR A FLIGHT.

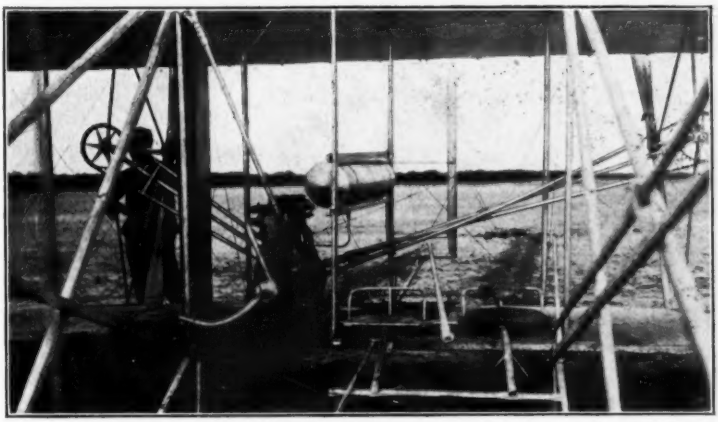
POWER GENERATION AND TRANSMISSION IN AEROPLANES.

By W. F. Bradley and H. W. Perry.

PRINCIPALLY as the result of the successful work of Wilbur Wright in France, European aeronautical-motor engineers have begun to doubt the wisdom of their special researches in the direction of great power with light weight. Formerly it was generally believed that weight was one of the greatest obstacles to flight, and that the lighter the engine the better. When flights of a few yards were looked upon as marvels, there was doubtless some ground for this belief; but now that half-a-dozen men, on various types of machines, have flown for more than a mile, and the most expert of them have remained aloft for more than an hour, the need for featherweight motors is no longer felt.

Wilbur Wright, undoubtedly the most successful of all aeroplanists, used in his flights in France last Fall, a gasoline motor of greater weight and lower power than the engines of any of his foreign rivals, thus proving conclusively that it is not necessary to possess a special engine in order to fly. Although the Wright power plant cannot be classed as an automobile engine, it is the least removed from motor-car standards of any aeronautical motor in existence. Its four separately cast, water-cooled cylinders have a bore of 4 inches and a stroke of 4½ inches, the normal engine speed being 1,100 revolutions per minute. This gives a normal rating of 30 horse power. All valves are in the cylinder heads, the exhaust valves being operated by overhead rocker arms and the inlets operating automatically. One of the most distinctive features of this engine is that the fuel charge is supplied by direct injection, gravity carrying the gasoline down from the tank to a pump within the crank case which

is driven by helicoidal gears off the cam shaft. Lubrication is positive by means of a plunger pump located within the crank case and also driven off the cam shaft. The engine is water cooled by means of forced circulation, the pump being driven from the forward end of the crank shaft. The radiator is an ingenious arrangement of flat aluminium tubes arranged vertically in four series of six each, united at the top by two collectors and at the base by two smaller ones, the tubes themselves being placed on either side of one of the upright supports connecting the two planes of the aeroplane. An Eisemann high-tension magneto, with separate high-tension coil, has been adopted exclusively for ignition. The magneto is driven directly off the cam shaft by exposed gears.



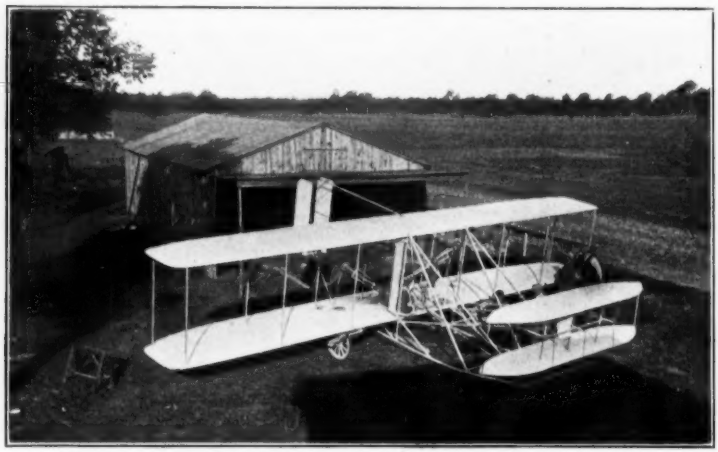
POWER PLANT AND DRIVING MECHANISM OF WILBUR WRIGHT'S AEROPLANE.

Note the two seats for aviator and passenger, the heavy engine, the chain drive to two rear propellers and the vertical flat tube radiator to the left of the engine.

As is generally known, two propellers, to the rear of the main planes and with two blades each, are employed. They are driven by means of chains, and, as the propellers are equidistant from the tips of the planes and the motor is at one side of the center, one chain is necessarily shorter than the other. The longer chain is crossed, in order that the propellers may turn in opposite directions, and both chains run in long, rather closely fitting metal tubes. With the largest size propellers, such as are employed for flights with a passenger aboard, the gear ratio is 10 to 33.

The operation of starting up is performed by two assistants who swing the propellers over by hand, and, once started, the operator has

no further need to concern himself with the engine which runs at constant speed. There is a slight ignition advance, but as the maximum advance is always given just before starting the aeroplane the care of the engine ceases then. To stop the engine an ignition cut-out is employed, the connection for which is merely a piece of twine stretched in front of the pilot. On more than one occasion when a passenger has been carried, the string has been touched inadvertently, with the result that the apparatus has come to earth.



FRONT VIEW OF WILBUR WRIGHT'S AEROPLANE AS USED IN FRANCE.

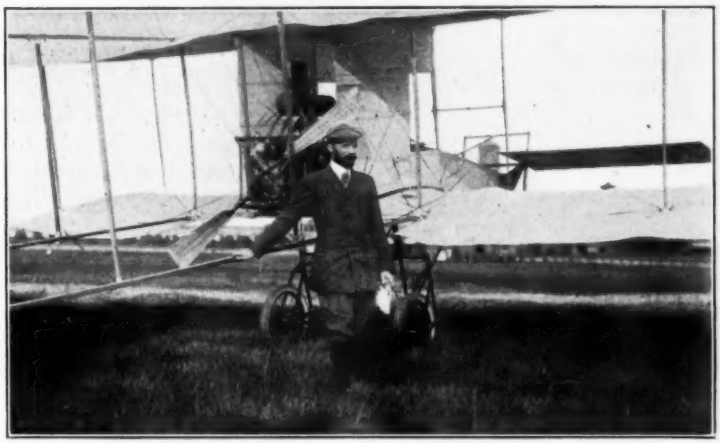
The small planes in front are used for ascending and descending, their angle being altered at will by a left-hand lever. The vertical planes in the rear control the lateral movements and are manipulated by a right-hand lever. Lateral equilibrium is obtained by twisting the rear corners of the "wings" upward or downward out of the normal plane by means of wires connected with the vertical-rudder lever.

In point of flights made, Henry Farman and Léon Delagrange must be classed as the most successful aeroplanists after Wilbur Wright. Both use aeroplanes built by Voisin Frères, fitted with eight-cylinder Antoinette engines. Levavasseur, the designer of the Antoinette, has studied the light-weight engine longer than any other man, and, largely by reason of being first in the field, has had more success than any of his rivals. Lavavasseur works on the principle that the greater the number of cylinders the lower the weight per horse power; no Antoinette engine has less than eight cylinders, and the more powerful have sixteen and twenty-four, the latter models having respectively two and three groups of eight cylinders on a special crank case.

THE ANTOINETTE MONOPLANE FITTED WITH ANTOINETTE MOTOR.

The designer Levasseur is standing in shirt sleeves under the right wing. Note the boat-shaped body with plain tube radiator along the side.

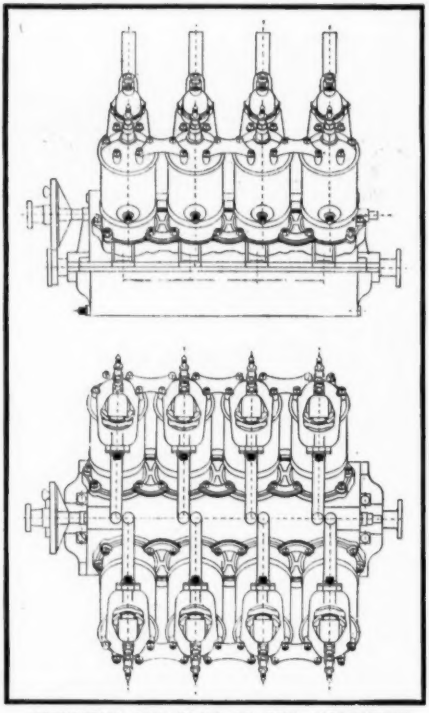
It is the eight-cylinder, 50 horse-power engine, however, that is used on the Farman and Delagrange aeroplanes and also on most of those constructed by the Antoinette company. The separate water-cooled cylinders, of 130 by 130 millimetres bore and stroke, are mounted at an angle of 45 degrees on an aluminium crank case having the form of a rectangular prism. The five-bearing, four-throw crank shaft receives two connecting rods per pin, each pair of pistons, at an angle of 90 degrees, being connected up to the same pin. The cylinders, cast separately and bolted on the crank case, have independent aluminium heads and copper water jackets. The exhaust



HENRY FARMAN AND HIS AEROPLANE AT BRIGHTON BEACH, NEW YORK.

The motor is a V-form, eight-cylinder, 50 horse-power Antoinette. Note the two-bladed propeller mounted on the end of the crank shaft.

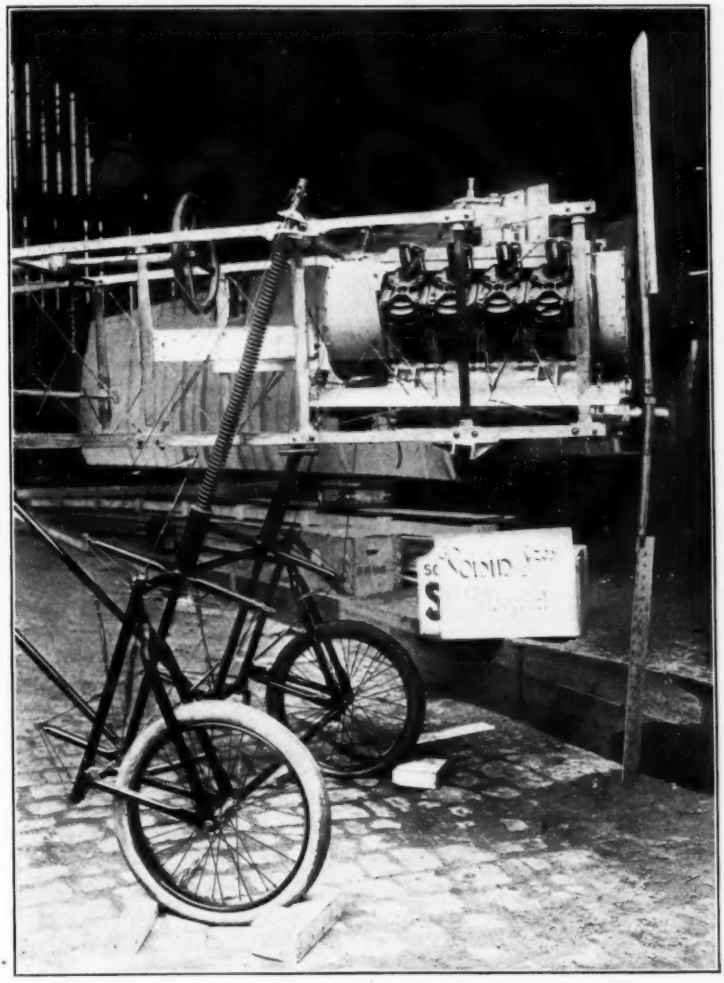
valves, operated by a single cam shaft with integral cams, are within the angle formed by the two cylinders. The inlet valves are automatic, for the Antoinette engine has no carbureter, the gasoline being injected directly into the cylinders by means of a pump and distributor.



ELEVATION AND PLAN OF THE ANTOINETTE V-FORM, EIGHT-CYLINDER, 50 HORSE-POWER MOTOR.

It is worthy of notice that the two most successful aeroplanes—the Wright and the Farman—both have water-cooled engines and direct injection of the charge. In each case the reasons given are a greater efficiency of the water-cooled over the air-cooled engine, and a greater certainty of obtaining regular running by direct injection than by the use of a carbureter. On the Antoinette engine the gasoline pump, driven direct by the engine and provided with a variable stroke in order to regulate the charge, supplies the fuel to eight small distributors, one in each cylinder head, where it is stored during the cycles other than aspiration. Ignition current is obtained generally from a storage battery with high-tension coil and distributor. When desired, however, a magneto is fitted, and in each case provision is made for variation of the firing point.

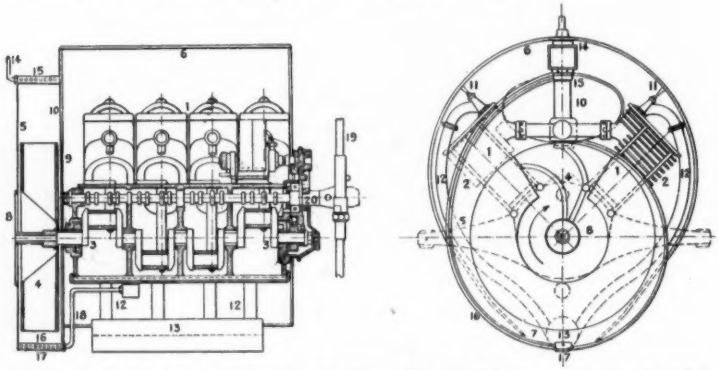
When first applied to aeroplanes, the Antoinette engines were fitted with a small water tank carrying two or three pints of water in addition to that in the jackets. As longer and longer flights have become possible, greater provision has had to be made for continuous running of the engine. Water circulation is now assured in all the machines by means of a gear-driven pump, and at present on the Delagrange and Farman aeroplanes a special type of plain



EARLY TYPE OF RENAULT V-FORM, EIGHT-CYLINDER MOTOR WITH BLOWERS.
Note spring suspension of the aeroplane frame on bicycle-type wheels, and hand wheel for controlling the movements of the flying machine.

tube radiator is employed. On their latest monoplane machine the Antoinette company has a plain aluminium tube radiator weighing but 26 pounds with its content of six quarts of water, this quantity being sufficient for a 50 horse-power engine. The aeroplane in question has a body in the form of a boat hull and it is on each side of this

that the long plain tubes are attached. Regarded from the standpoint of the constructor, the machine is one of the finest pieces of workmanship ever produced, in strong contrast to some of the earlier machines with which attempts were made to navigate the air.



VERTICAL SECTION AND TRANSVERSE DRAWING OF THE LATEST TYPE OF RENAULT 45 HORSE-POWER MOTOR.

4, fan; 6, sheet metal casing; 7, outlet of forced draught; 8, air intake to blower; 12, exhaust pipes; 13, muffler; 15 and 17, air-cooled oil pipes; 18, lead from lubricator pump; 19, propeller mounted on cam shaft.

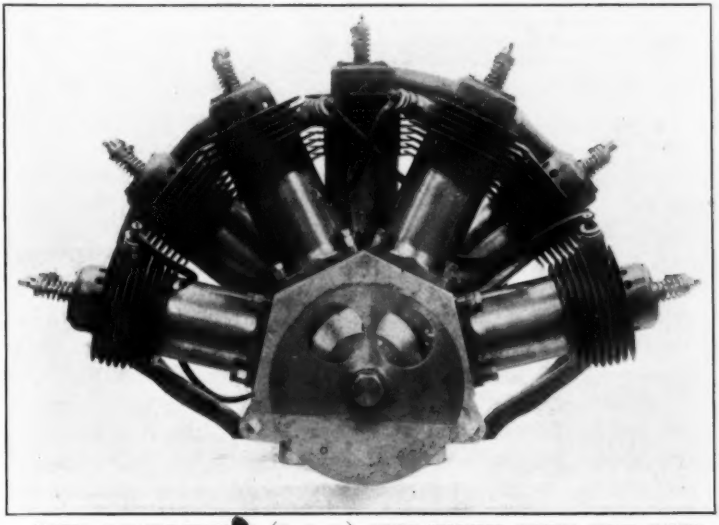
Lubrication, an important point in an engine having all its parts machined to the thousandth part of a millimetre, is assured by means of a gear-driven pump which draws the oil from the lower portion of the crank chamber and distributes it through a sprayer in the upper portion. As splash lubrication is also provided, the crank shaft, cam shaft and cylinder walls are always certain of a sufficient supply of oil. The crank case is divided into four compartments in order to assure a splash feed whatever the angle of the engine.

On the Farman and Delagrange aeroplanes, as indeed on all the French machines, the propeller is mounted directly on the crank shaft, turning of course at the same speed as the engine. This is contrary to Wright's practice, on whose machine the propellers, instead of having a speed of 1,000 to 1,200 revolutions per minute, do not turn at more than 400 revolutions per minute.

An Antoinette engine of 130 millimetres bore and stroke weighs 220 pounds empty; to this should be added, however, from 30 to 45 pounds for such accessories as gasoline, oil and water pumps, storage battery, spark plugs, piping, etc. A sixteen-cylinder engine of 80 millimetres bore and stroke weighs 165 pounds, but to this should also be added about 45 pounds for accessories.

Renault is the first among the large European firms of automo-

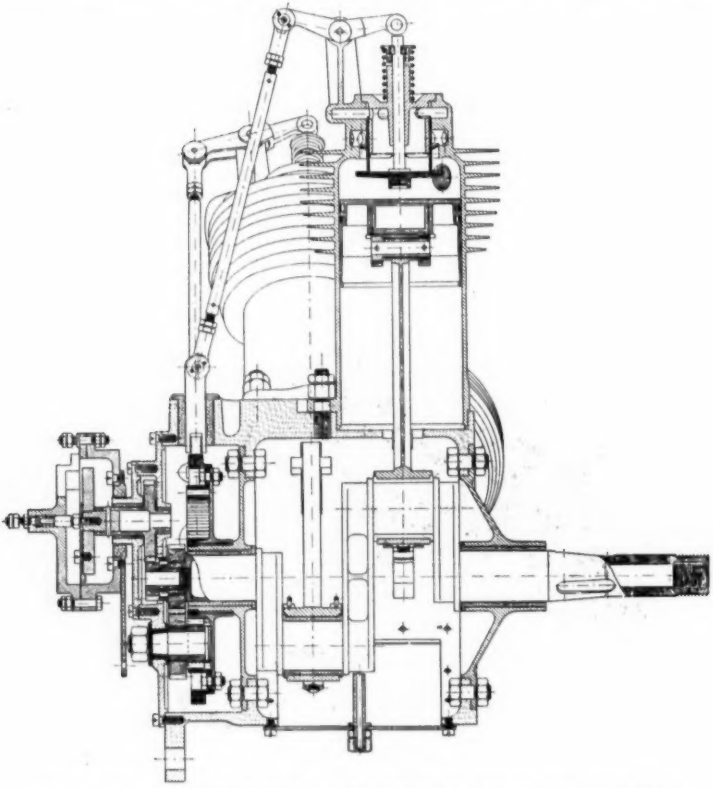
bile constructors to pay especial attention to the light-weight explosion motor for aeroplanes. The Renault aero engine, which is rated at 45 horse power, has eight air-cooled cylinders arranged in V form, each having a bore of 90 millimetres and a stroke of 120. The crank shaft has four throws and five bearings with two connecting rods to each pin, in this respect being similar to that of the Antoinette. The sixteen valves, which are within the angle formed by the two sets of cylinders, are all mechanically operated from a single cam shaft, the exhausts, which are above the inlets, being operated by overhead rocker arms. The carbureter is similar in principle to the one used on the touring cars, the Renault engineers being of opinion that although there is a slight gain in weight by using direct injection, the fuel consumption is so greatly increased that the advantage is nullified. Ignition, too, follows motor-car practice, a high-tension Bosch magneto, carried in a reversed position under the forward extension of the crank shaft, being adopted in preference to storage batteries or dry cells.



ROBERT ESNAULT-PELTERIE (R. E. P.) SEVEN-CYLINDER ENGINE WITH VALVE-OPERATING MECHANISM REMOVED.

At 1,500 revolutions, the power developed is 45 horse power, and by increasing the speed to 1,600 revolutions 48 horse power can be obtained. A distinctive characteristic of this engine is that the propeller, instead of being mounted on the crank shaft, as is usually the case with European aero motors, is fitted on the rear of the cam

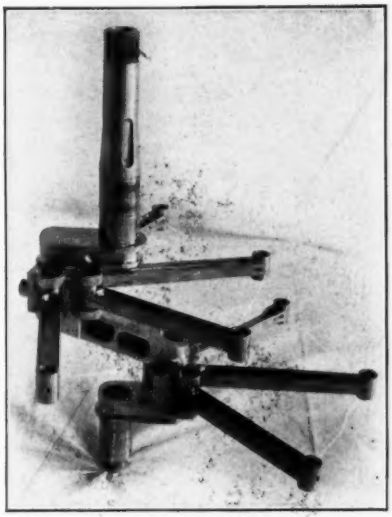
shaft, thus revolving at half the engine speed. Cooling of the cylinders is aided by means of a centrifugal fan mounted directly on the forward end of the crank shaft and a double sheet-metal casing surrounding both the engine and the fan. On the first models produced two fans were fitted, one at either end of the engine; this arrangement, however, was found to be inefficient, and a single fan was



CROSS SECTION OF THE R. E. P. ENGINE THROUGH ONE OF THE CYLINDERS.
Note two-throw crank shaft.

adopted with the casing of such a nature that the draft was directed around all the fins of the cylinders, around the exhaust pipes, and finally discharged at the engine base on the exhaust box carried longitudinally under the motor. Advantage is taken of the forced draft to cool not only the cylinders but also the lubricating oil. On leaving the base of the crank chamber, which forms an oil reservoir,

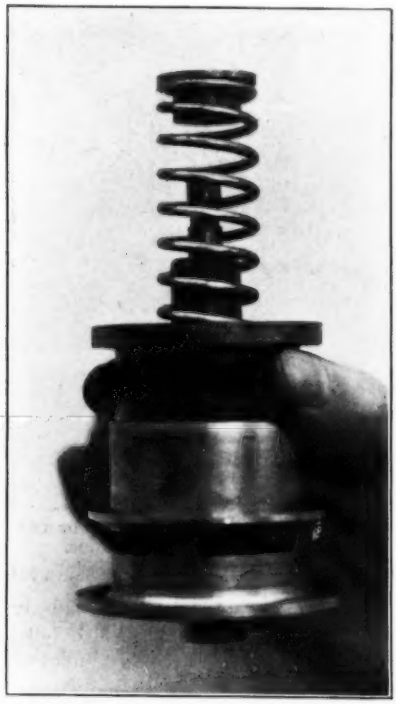
the lubricant passes through tubes in the base and head of the casing of the ventilator before arriving at the tank from which it is fed by sight feeds to the engine bearings. Circulation is of course assured by a gear-driven pump. With full equipment, but with gasoline and oil tanks empty, the Renault engine weighs 312 pounds.



CRANK SHAFT AND CONNECTING ROD OF THE R. E. P. SEVEN-CYLINDER MOTOR.

Excluding the many engines which have been designed, built and run for a certain length of time on the testing block only, Robert Esnault-Pelterie has the honor of producing the most original and at the same time the lightest engine ever used for aerial work. The Esnault-Pelterie is not a light engine by reason of careful selection and skilful working of metals, but because of its peculiar design. Either five or seven cylinders are employed, although the latter number is much more common than the smaller number. The seven cylinders, each with radiating fins, are staggered around the upper half of a circular crank case, three being in one plane and four in another. The two-throw crank shaft, one of the most original features of the engine, receives three connecting rods to one pin and four to the other; in reality, there are only two direct connections to the crank shaft, the connecting-rod bearings having in one case two supplemental radiating arms and in the other three, to each of which is attached a piston. The steel pistons, machined out of the solid, have a very much thinner wall than is usually considered possible for an internal-combustion motor, because the connecting rod is not attached to the wall but to a special double bearing screwed into the piston head.

The valves and valve-operating mechanism are no less original than any other part of the engine. Thus, the charge is aspired and the waste gases cleared through the same valve in the cylinder head, operated by overhead rocker arms. The valve consists of a vertical cylinder, a central stem and a flange fitting on the valve seat as in the



COMBINED MECHANICALLY OPERATED INLET AND EXHAUST VALVE OF THE R. E. P. MOTOR.

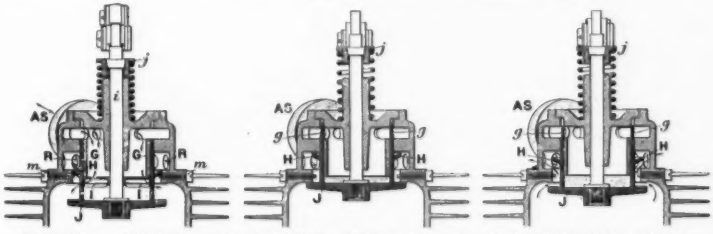
ordinary type of poppet valve. Above the valve proper is a circular collar or sleeve which, according to its position in the cylinder, opens or closes a series of ports. There are three principal positions of the valve, corresponding to three bosses on the cam shaft. If the valve stem is on the highest boss of the cam, the poppet valve is lifted from its seat, gas passes through the cylindrical casing and enters the cylinder through the open ports; the collar is in such a position that communication with the exhaust pipes is cut off. When the valve stem drops down to its lowest position, the valve closes in the same way as an ordinary poppet valve, closing all connection with both the inlet and the exhaust. At the intermediate position, the valve is slightly raised from its seat, allowing the escape of the spent gases, while the collar closes connection with the intake pipe. A single circular cam operates all valves. In reality it is a two-face cam, for, owing to the necessity for staggering the cylinders in order to occupy only the upper half of the crank case, one set of cams must be a little to the rear of the others. This large single cam, with its two faces, one carrying six, and the other eight, bosses, is mounted on the axis of the crank shaft and is revolved at one-sixth of the engine speed by means of suitable gearing.

There are two carbureters, one supplying three, and the other four, cylinders. The ignition, which is obtained by means of storage batteries and a trembler coil, presents nothing of especial novelty. Lubrication is by splash only, but because of the varied positions of the cylinders, the central one being vertical and the outside ones inclined more than 45 degrees, baffle plates are fitted at the bases of the

cylinders of such form and size as to limit the supply of oil to those cylinders which, by reason of their position, would be likely to take up an excess.

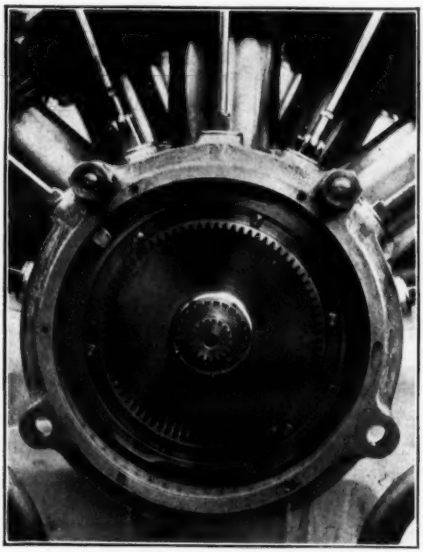
The seven-cylinder engine complete weighs 114 pounds, which is an extraordinarily low weight for a machine developing 35 horse power. The crank shaft, although provided with a particularly wide bearing at its outer end—the end to which the propeller is attached—weighs only 5½ pounds; the crank case complete with bolts weighs 11½ pounds; each of the pistons complete with two rings weighs 1 3-10 pounds. The principal use of the Esnault-Pelterie engine has been on an aeroplane designed by its inventor which is commonly known as the R. E. P. There is no transmission, for the four-bladed propeller is mounted direct on the crank shaft and revolves without any intermediate gearing at the engine speed.

It would be possible to extend the list of aeronautical engines almost indefinitely, for the number of aeroplanes and special aero engines constructed in Europe appears to be almost unlimited. Those that have actually been used for aerial navigation, however, are exceedingly few, and those that are capable of being used, in their present condition, still fewer. Some interesting experiments in rotary motors have been made by both Farcot and Burlat, who place four and eight cylinders at equal distances around a circular crank case, the pistons being connected up to a one-throw crank shaft. The difficulty here is largely one of lubrication. The most valuable of the Farcot series are a two- and an eight-cylinder engine with an original type of combined inlet and exhaust valve having a certain resemblance to the one invented by Robert Esnault-Pelterie.



SECTIONAL DRAWINGS ILLUSTRATING ACTION OF R. E. P. COMBINATION VALVE. AS, inlet; R, holes for open exhaust; G, sleeve; H, small collar; I, ports in sleeve; J, flat valve; *g g*, walls of sleeve closing inlet holes.

Aside from the Wright brothers' aeroplanes, the only heavier-than-air machines that have made fully authenticated successful flights in America up to this time of writing are the three biplane fliers built and flown by the Aerial Experiment Association at Ham-



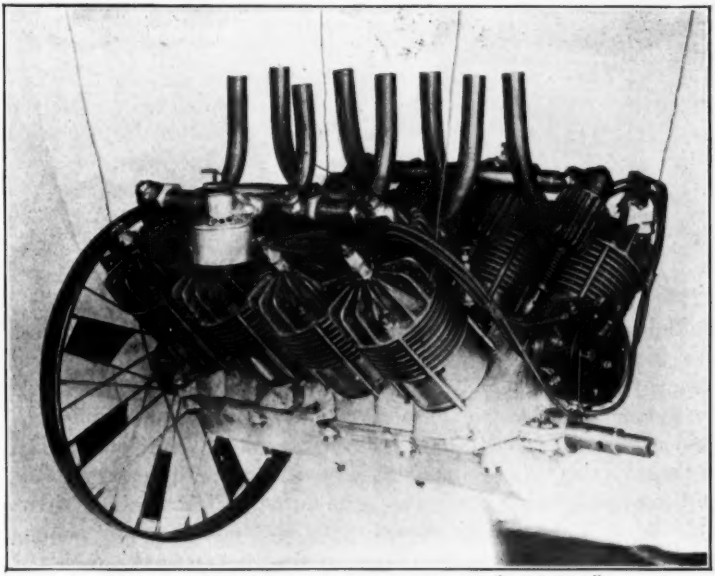
R. E. P. MOTOR WITH FRONT OF CRANK CASE REMOVED, SHOWING SINGLE CAM FOR ALL VALVES.

mondsport, N. Y. These are known as the "Red Wing," the "White Wing" and the "June Bug," or as "Aerodromes" Nos. 1, 2 and 3. The engine used in all three of these machines is the Curtiss air-cooled gasoline motor. It will suffice to illustrate and describe the motor used in the "June Bug," the third machine of the series and the one that on July 4 last won the International silver trophy offered by the *Scientific American* through the Aero Club of America for the first heavier-than-air machine to fly a distance of one kilometre measured in a straight line in the presence of official timers. The engine weighs 150 pounds and is rated at 40 horse power. It has eight cylinders arranged in two rows at an angle of 90 degrees, as in the Antoinette, and offset or staggered. This arrangement is compact and gives great power per pound of weight. The cylinders have a bore of 3⅝ inches and the pistons a stroke of 3¼ inches. The normal speed is 1,800 revolutions a minute. The cylinders are cast separately and have finned heads and auxiliary exhaust ports on the lower side beneath the last radiating flanges. Inlet and exhaust valves are all located on the upper and inner sides of the heads, and the push rods are so disposed that all valves can be operated by a single cam shaft located inside the crank case in the same vertical plane as the crank shaft. On one end of the cam shaft is mounted the ignition current distributor, with its cables leading through supports to the spark plugs inserted through the centers of the heads. The exhaust valves open into upward curved pipes that exhaust directly into the air.

The illustration shows two carbureters, each feeding a single bank of cylinders, but as used on the "June Bug" there was one carbureter for each cylinder. The carbureters are especially de-

signed for lightness and for use on aeronautical engines. They weigh only 15 ounces each, have a central fuel feed, and an adjustable automatic air supply, so that they give automatically a uniform mixture at varying speeds and are not affected by changes in position. A light balance wheel having steel spokes and rim and fitted with vanes to act as a fan in aiding cooling, is keyed to one end of the crank shaft; the double-bladed propeller is attached to the other.

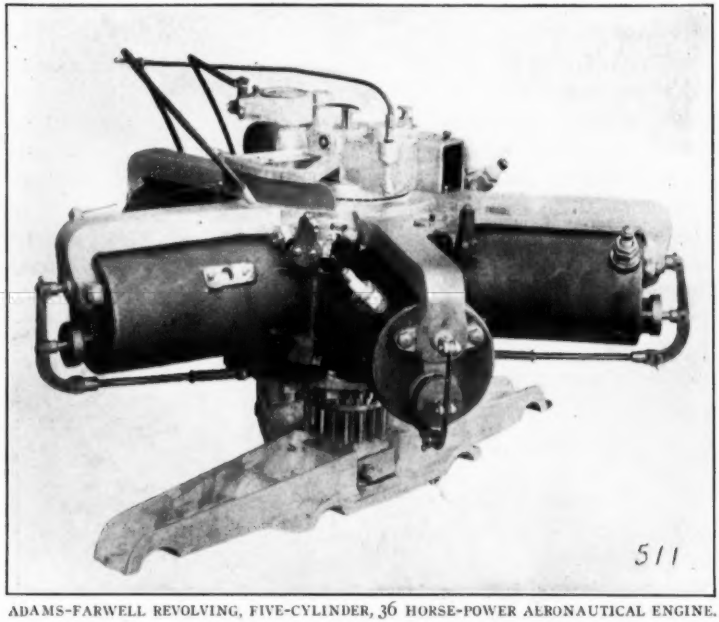
A Curtiss engine is used also on the Baldwin dirigible balloon which successfully passed the government tests at Fort Myer in September and was accepted by the United States Army for use by the Signal Corps. In this case, however, the engine has but four cylinders and is of the vertical type. It has a weight of 110 pounds and is rated at 25 horse power. The dimensions are: height, 18 inches; length, 20 inches; width between base supports, 7 inches. The cylinders have a bore of 3⅝ inches and a stroke of 4 inches. The engine is designed to run at a normal speed of 1,800 revolutions per minute. The crank shaft, which is 1¼ inches in diameter, is fitted with a light balance wheel and with a small sprocket to carry the chain that drives the long propeller shaft in the framework suspended from the gas bag. The rear extension of the crank shaft



CURTISS 40 HORSE-POWER MOTOR USED IN THE "JUNE BUG."

is fitted with a spur gear that drives the cam shaft, to which the distributor is attached and which in turn drives the shaft of the magneto. This magneto weighs 9 pounds, somewhat less than batteries and coil.

Airship engines of one and two cylinders are also built at Hammondsport on the same lines as motorcycle engines. They are furnished in 3 and 7 horse-power sizes, while the four-cylinder motors are made in both air-cooled and water-cooled models of 15, 20, 25 and 50 horse power, and the eight-cylinder V engines in air-cooled type only, of 30 and 40 horse power.



ADAMS-FARWELL REVOLVING, FIVE-CYLINDER, 36 HORSE-POWER AERONAUTICAL ENGINE.

It is indicative of the activity in aeronautical lines in America that more than fifty such engines were built last year by a single company, and that in Dubuque, Iowa, a company that has been building automobiles for a number of years, has this year brought out a light engine of 36 horse power for aeronautical use. This belongs to the revolving-cylinder type, having five cylinders disposed radially with connecting rods acting on a one-throw stationary crank shaft. This Adams-Farwell engine weighs only 97¼ pounds, or 2.7 pounds per horse power. About 85 per cent of the whole weight revolves in a horizontal plane, giving a gyroscopic effect. The engine is air cooled and the valve mechanism very simple.

MEANS AND METHODS OF HEATING THE FEED WATER OF STEAM BOILERS.

By Reginald Pelham Bolton.

II. FEED HEATING BY THE USE OF LIVE STEAM.

In the first article of his series, presented last month, Mr. Bolton examined the general question of the gain or loss by feed heating and the special case of feed heating by means of waste furnace gases. In the present section he discusses the economy of heating by live steam. A concluding instalment next month will deal in a similar manner with the economy of exhaust-steam heating.—The Editors.

IN the first part of this discussion it was shown that the heating of feed water to high temperature may find a possible value in certain boilers, by the promotion of their internal circulation. More often it finds a justification in the removal, by the higher temperature, of scale-making or acid elements; deposits of the former retard the heat transfer through the plates, while the presence of the latter may cause physical injury to the interior part of the structure.

If this high temperature cannot be produced by waste material, but must be effected by the heat already produced in the live steam, the process is accompanied by some loss of that heat, in the portion dissipated in radiation from pipes and heaters and also in any waste elements in the feed water which are heated only to be thrown away. The well-known forms of "live-steam purifiers," are really open heaters on the contact system, being practically extensions of the steam space, placed high enough above the water level in the boiler to afford a sufficient head or height of the feed-water level maintained in the purifier to overcome friction in the feed piping and in the check and feed valves. The cost of the additional heat thus imparted to the feed water is that of the heat lost in radiation and in raising the temperature of the waste materials, to which must be added the cost of any additional pumping of the feed. (Chart I.)

The same class of work is accomplished in the marine "evaporator," which is really a live-steam heater of the surface or closed type. In this apparatus, to make up deficiencies in the return system from a condensing engine, sea water is boiled to steam, and the deposited salts are blown down to waste in the form of concentrated brine. The process is a necessary one in steam vessels in order to avoid the carriage of large quantities of fresh water.

The system of evaporating this feed water can be made very economical if proper disposition be made of the heat contained in the steam. As shown in Chart II, the steam may be raised to a pressure corresponding to that in the low-pressure receiver of the engine. It may be utilized for work in that cylinder, cutting down the cost by the work thus secured, but its cost in boiler heat may be lessened to a much greater extent by its introduction direct into the feed system, in a contact heater. In a series of evaporators, the steam can be used in double or triple effect. The result of this method was tested by Lieut. Newton Mansfield, on the U. S. S. Dixie,* the evaporated steam being passed from one evaporator to two others, from which it was trapped to a distiller and there cooled. Running single effect, 1 pound of water was obtained for 0.266 pound of coal, or, at say 7 to 1 evaporation in the boiler, 1 pound of steam at boiler pressure for 1.86 pounds of coal. Running double effect, this was reduced to 0.99 pound.

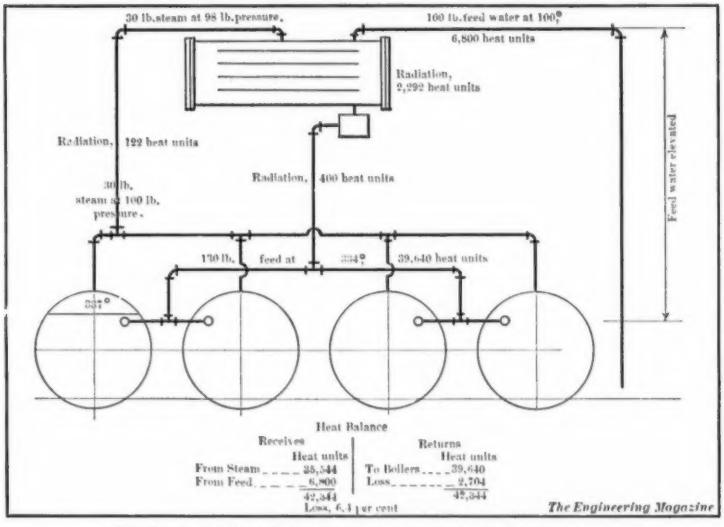


CHART I. HEAT BALANCE OF THE LIVE-STEAM PURIFIER.

Another method with a single evaporator, is to borrow steam for the process from the high-pressure receiver on the main engine, and to discharge the evaporated steam into the low-pressure receiver, thus losing only the useful work of the initial supply in the intermediate cylinders. The most economical method, however, is to de-

* Jour. Am. Soc. Naval Engineers, Vol. XII, Part 2.

liver the evaporated product direct to the contact heater, as shown on Chart II. The net cost per pound then amounts to 867 heat units when the steam is taken to the low-pressure cylinder, 159 heat units when it is condensed direct into the feed.

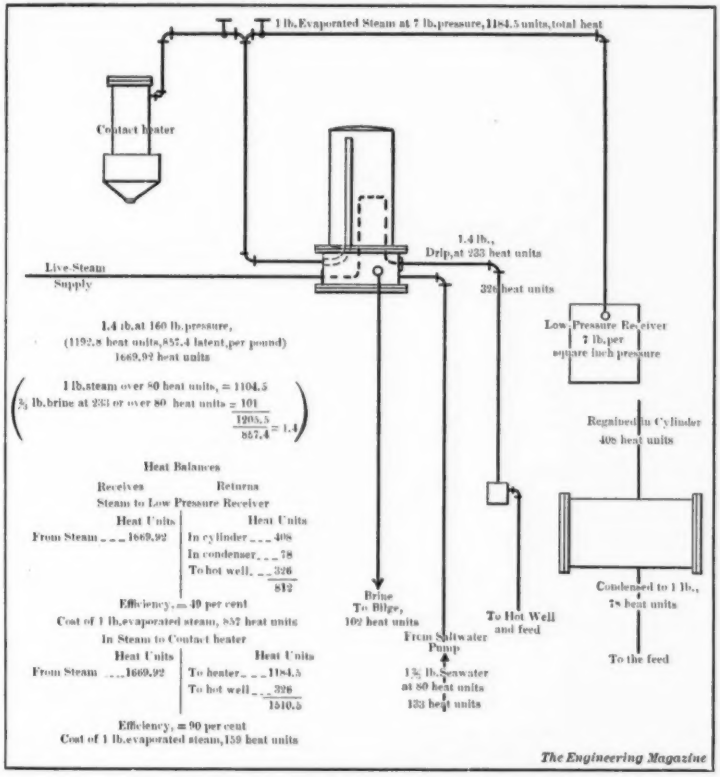
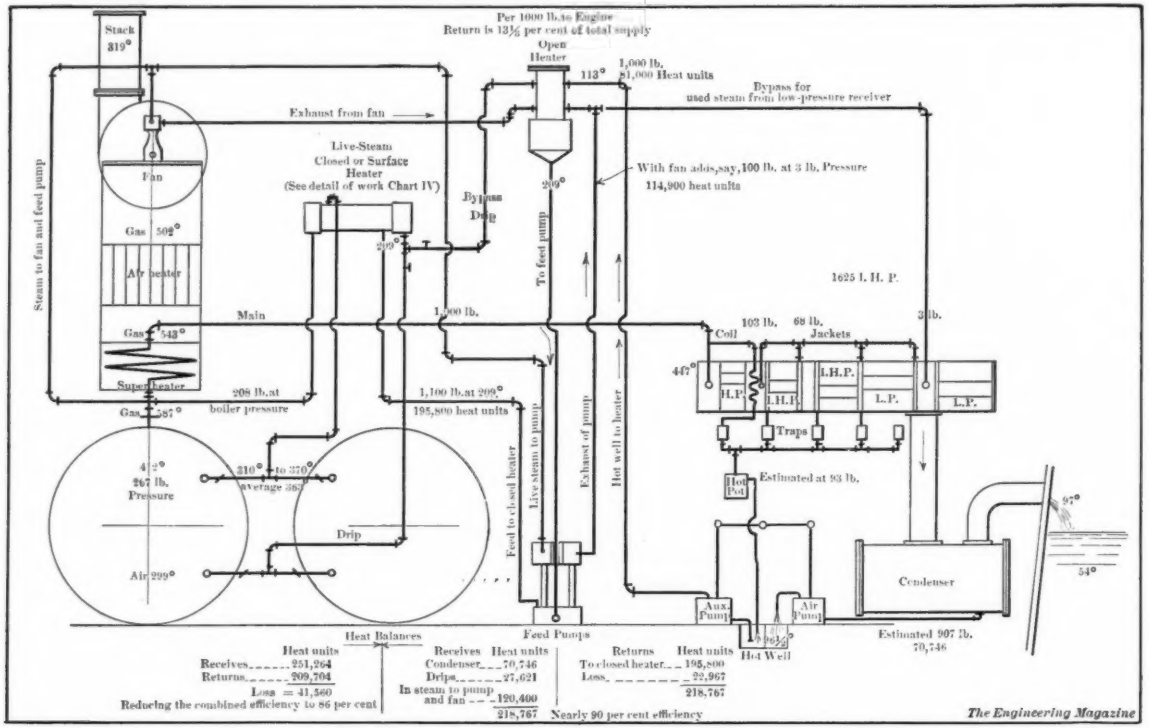

1 lb. Evaporated Steam at 7 lb. pressure, 1184.5 units, total heat
Contact heater
Live Steam Supply
1.4 lb., Drip, at 233 heat units
326 heat units
Low Pressure Receiver 7 lb. per square inch pressure
1.4 lb. at 160 lb. pressure, (1192.8 heat units, 857.4 latent, per pound) 1669.92 heat units
1 lb. steam over 80 heat units, = 1104.5
⅓ lb. brine at 231 or over 80 heat units = 101
1205.5 / 857.4 = 1.4
Regained in Cylinder 408 heat units
Heat Balances
Receives
Returns
Steam to Low Pressure Receiver
Heat Units
From Steam ... 1669.92
Heat Units
In cylinder ... 408
In condenser ... 78
To hot well ... 326
812
Efficiency, = 49 per cent
Cost of 1 lb. evaporated steam, 857 heat units
Brine To Bilge, 102 heat units
To Hot Well and feed
From Saltwater Pump
1⅓ lb. Seawater at 80 heat units
133 heat units
Condensed to 1 lb., 78 heat units
To the feed
In Steam to Contact heater
Heat Units
From Steam ... 1669.92
Heat Units
To heater ... 1184.5
To hot well ... 326
1510.5
Efficiency, = 90 per cent
Cost of 1 lb. evaporated steam, 159 heat units
The Engineering Magazine

CHART II. HEAT BALANCE OF THE LIVE-STEAM EVAPORATOR.

The Engineer, London, in a recent article* on the subject of the possible advantages derivable from feed-water heating by means of live steam, bases some argument as to its value upon the assertion that there are "dozens, if not hundreds, of live-steam feed-water heaters in regular use in steamships," the use of which is assumed to demonstrate that their owners or operating engineers must find them to produce an economy. This argument is placed against the record of the recent careful test, by Messrs. Goodman and Maclachlan, of the

* Quoted at length in THE ENGINEERING MAGAZINE for May, 1908, page 259.



Heat Balances

Heat units		Receives	Heat units	Returns	Heat units
Receives	251,264	Condenser	70,746	To closed heater	195,800
Returns	209,704	Drips	27,621	Loss	22,967
Loss =	41,560	In steam to pump and fan	120,400		218,767
			218,767		

Reducing the combined efficiency to 86 per cent

Nearly 90 per cent efficiency

The Engineering Magazine

CHART III. HEAT BALANCE AND ARRANGEMENT OF AUXILIARIES AND FEED-HEATING APPARATUS ON THE SS. "INCHDUNE."

use of a live-steam heater with a land boiler, in which it was demonstrated that there was no advantage, nor was there any particular loss in that instance, in the use of a live-steam heater. This rather negative result seems to indicate, however, that the particular boiler did derive from the introduction of feed water at steam temperature an advantage in internal circulation which just balanced the loss of heat by the process of ad-heating the feed water.

This result was predicted long ago by James Weir, in his work on "Terrestrial Energy," as follows:—

> "The heat that is carried into the boiler by the feed represents an excess that has come out of the boiler and passed through the engine. Exhaust steam and waste heat must be used to effect economy.
>
> "By using steam direct the result will be neither loss nor gain, but the effective amount of steam the boiler will produce without priming, will be diminished in proportion to the quantity taken from it to the feed."

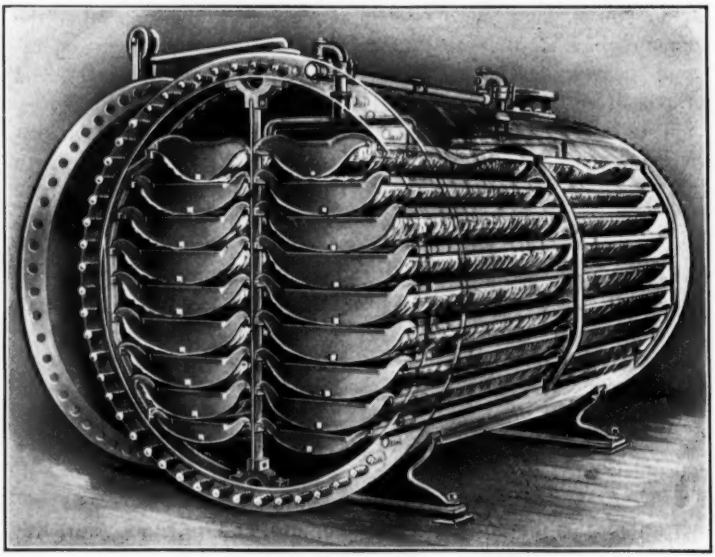
The assertion that there is any large number of live-steam feed-water heaters in use in steamships is open to doubt, and, as far as any advantage can be shown by those that are in operation, it would probably be found, upon close examination of the conditions, that the economy which is attributed to their use is to be found in the operation of the combined details of furnace, boiler, draft, machinery, and methods of absorption of waste heat into the feed water.

The most successful marine installations in which closed or surface live-steam heaters are used, are those in the vessels of the Inch Line, the economical performances of which are remarkable.* These vessels have a combination of appliances and systems, which, when taken together, have resulted in the production of an indicated horse power in the main engines for less than 1 pound of fuel. For the purpose of illustrating the small part which is played in the combination by the live-steam heater, I have prepared the accompanying diagram (Chart III) of the combined appliances. These appliances, used in conjunction with an unusually high pressure, induced draft and effective heating of the furnace air-supply, include a superheater, steam jackets, a reheater in the intermediate receiver, five-cylinder quadruple-expansion engines, jacket traps discharging to feed return, an open or contact heater utilizing the exhausts of some auxiliaries, other auxiliaries driven by the main engines, and, in connection with all of these, a live-steam heater.

The foregoing elements make an interesting and economical combination. The furnace air is pre-heated to 299 degrees F., and the temperature of the gases of combustion, which is 587 degrees, is

* *Engineering*, London, January 18, 1901.

reduced 44 degrees by the superheater and 41 degrees by the air-tubes, so that the gases emerge from the stack at only 319 degrees. A moderate amount of superheat, 57.45 degrees, is attained, of which 22.5 degrees is lost in radiation on the way to the high-pressure steam chest, due, it is stated, to insufficient insulation. The first receiver is fitted with a coil to which superheated steam is admitted, so as to re-heat the exhaust from the high-pressure cylinder, and this supply is then utilized in the jackets of the intermediate-pressure and low-pressure cylinders, which are all closely covered, not only on the sides, but also on the heads. The drips from these points are then trapped, and the superheated water is discharged to a receiver or hot pot, whence it is introduced into the feed water in the hot well. The air pump and the circulating and hot-well pumps are driven by the main engines, but the boiler feed pump and the fan engines exhaust into a contact or open heater, where the temperature of the feed water is raised by the exhaust steam from these auxiliaries from 113 degrees, at which it enters the contact heater, to a tempera-



HOPPES LIVE-STEAM FEED-WATER PURIFIER.

Placed above the boilers, and filled with live steam at boiler pressure by a steam pipe at the top. The water is pumped in at the top and flows to the boilers through a "gravity pipe." On its way down it overflows the pans, following the under side and depositing the precipitated solids. A removable front head gives easy access for removing and cleaning the pans. Hoppes Manufacturing Company, Springfield, Ohio.

ture of 209 degrees, at which it enters the live-steam heater. So far, the process of recovering waste heat, and of ad-heating the feed water thereby, is one of accumulating recovery of otherwise lost material, and the efficiency of the system, even if charged with the steam required for the operation of the hot-well pump, is very high.

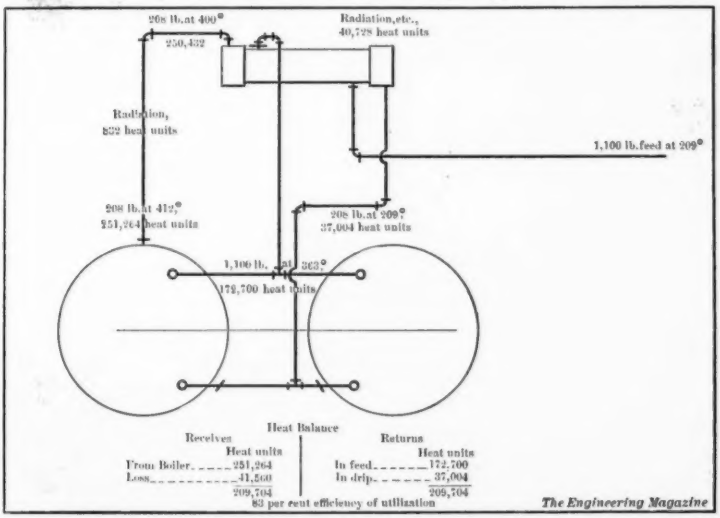
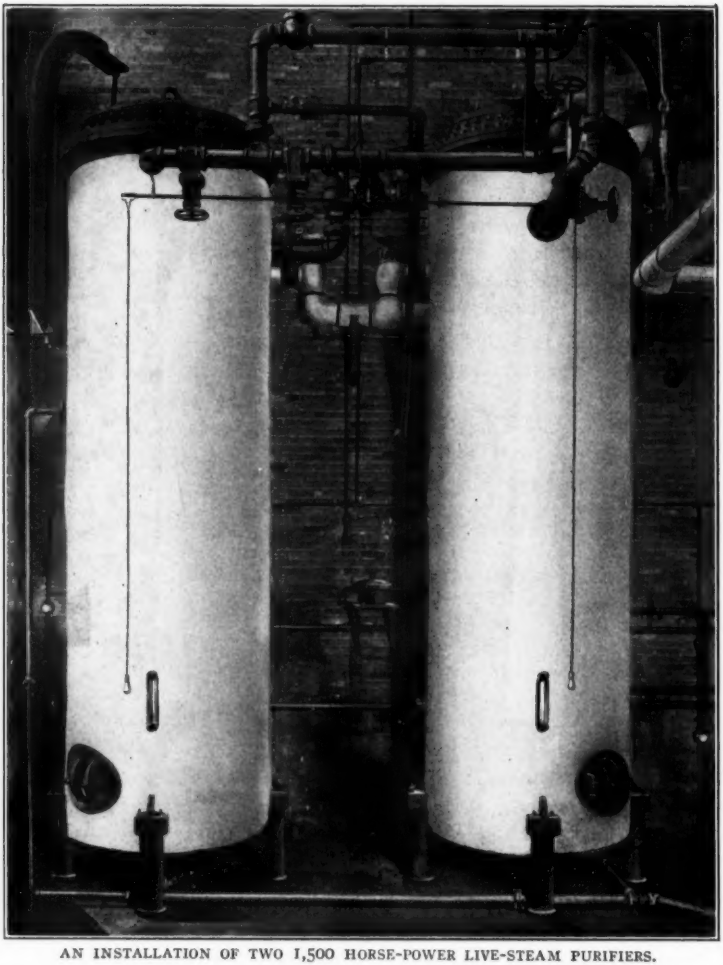


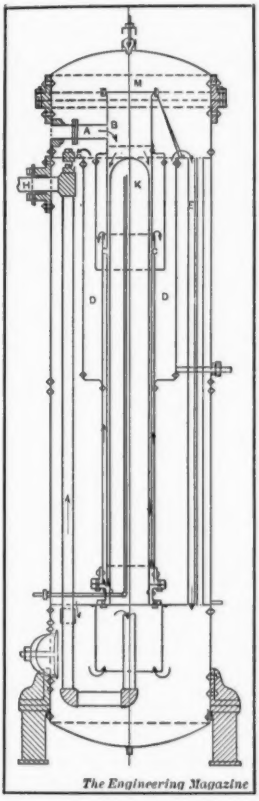
CHART IV. HEAT BALANCE OF THE LIVE-STEAM CLOSED HEATER AS INSTALLED ON THE SS. "INCHDUNE."

The live-steam heater, arranged as shown in Chart IV, was designed to receive either boiler steam or superheated steam and to return the condensation direct to the two boilers. The return made in this manner is productive of the least possible loss, but it was abandoned, on account, it is stated, of its uncertainty. In the system then adopted, the discharge was trapped and led up to the contact heater, involving the ad-heating by more live steam of the condensed water due to the work of heating in the live-steam heater, a process of accumulation which evidently found a balance at some figure between 310 degrees and 370 degrees of final feed temperature. The temperature of steam supply to the heater is stated to have been 400 degrees, so that the steam was no doubt taken from the boiler, and not from the superheater. Under these circumstances, the feed, entering at 209 degrees, was delivered to the boiler at from 310 degrees to 370 degrees. The lower temperature is stated to have been due to the inefficiency of the traps, and the higher we may assume to have been the best attained when all conditions were favorable. The



AN INSTALLATION OF TWO 1,500 HORSE-POWER LIVE-STEAM PURIFIERS.
The Eclipse Feed Water Heater and Purifier Co., Oshkosh, Wis.

efficiency of the combined appliances for heat recovery as far as, and up to, the inlet of the live-steam heater, is nearly 90 per cent, but the efficiency of the live-steam heater under the best conditions reduces the combined efficiency to 86 per cent. This reduction represents a direct loss of 41.5 heat units per pound of steam delivered to the main engines, which is no doubt lost sight of in the general good effect.



DIAGRAMMATIC VIEW OF THE "ECLIPSE" PURIFIER.*

In the face of this concrete example, in the steam plant of a vessel of the highest efficiency, it is not possible to maintain that the live-steam heater is a source of economy in itself. It may well be, however, that in this instance, as in others, the high pressure and temperature of the steam supply rendered it very desirable that the feed should by some means be introduced at a relatively high temperature, to avoid racking strains on the boiler of the particular type employed, which was operating at a high furnace temperature. The reduction of the cost of maintenance, and the avoidance of unnecessary leakages, may well pay for the cost of the live steam in the feed-heating process, but it should not be assumed that the same effects would be found in connection with a boiler of a different type and working under less strenuous conditions. The general conclusion on the subject of the use of live steam in this connection would, therefore, appear to be, that it is a source of inevitable direct loss, but that this loss may be outweighed, in the types of boilers which are internally fired, by the effects of better circulation promoted by the ad-heated feed water. The application of live-steam heaters should be made only to ad-heat feed water in which all possible sources of waste or used heat have already been utilized, and from which all air and gases have been removed. The process may be applied with advantage to the separation of deleterious materials from feed water, when these are to be eliminated only by the high temperature involved. The live-steam heater should be so arranged as to return its condensation as directly as possible to the boiler.

* The water entering the chamber B through the pipe A is forced between the chambers B and K—a live-steam chamber—in a very thin sheet into the chamber C which is surrounded by live steam. It then enters the settling chamber D which is fitted with a blow-off for discharging sediment. Thence it rises to chamber M where cooling by the cold water in B causes the deposition of scale-forming materials. The water is then forced through small tubes E, surrounded by live steam, into a final settling chamber from which it is drawn to the boilers through the pipe H. The final temperature is about 300 degrees F.

MICROSCOPIC METALLOGRAPHY AND ITS EMPLOYMENT IN FRENCH INDUSTRIES.

By Jacques Boyer.

Modern engineering and mechanical construction demands other and better knowledge of materials than the old chemical and physical tests could afford, and of all the new modes of examination metallography has proved most efficient and most useful. It has received much attention on the Continent, largely because of the earlier demand there created by the development of the exacting demands for extraordinarily high service in motor-car and ordnance work. Prof. Boyer's article details the practice followed in some of the most celebrated French establishments, by authorities whose names have become celebrated throughout the whole world of engineering.—THE EDITORS.

METALLOGRAPHY is finding constantly enlarging utilization in the industries. As is well-known, it is a method of testing which proceeds by examining microscopically a highly-polished metal surface that has been submitted to the action of a reagent. By this the diverse constituents are differentiated, some being attacked, while others are not. Thanks to the perfections introduced into the necessary technical operations, the method has come into current use in France, being employed, for example, in the Creusot Works, establishments of the Société de Constructions Mécaniques at Denian (Nord), of the Compagnie des Fonderies, Forges et Aciéries de Saint-Etienne (Loire), of the Société Métallurgique de la Bonville (Eure), in the great de Dion-Bouton shops at Puteaux, near Paris, and in many other establishments working in iron, steel, bronze, brass, and other alloys of copper. Furthermore, micrographic observations of this kind are nowadays executed very rapidly, as it is possible to polish, etch, and photograph a sample in about twenty minutes.

Let us take up the various steps of a metallographic examination and see what information of industrial value may be derived.

First, the sample must be cut. Certain precautions are necessary to prevent alteration of the substance during this operation, which is performed with a saw in the case of most metals and alloys. In particular, heating of the piece is avoided by running the saw at slow speed and flooding it with soap and water and oil. Ordinary annealed steels, bronzes, brasses and many common alloys are thus sectioned. Some others, however, must be cut with very thin carborundum

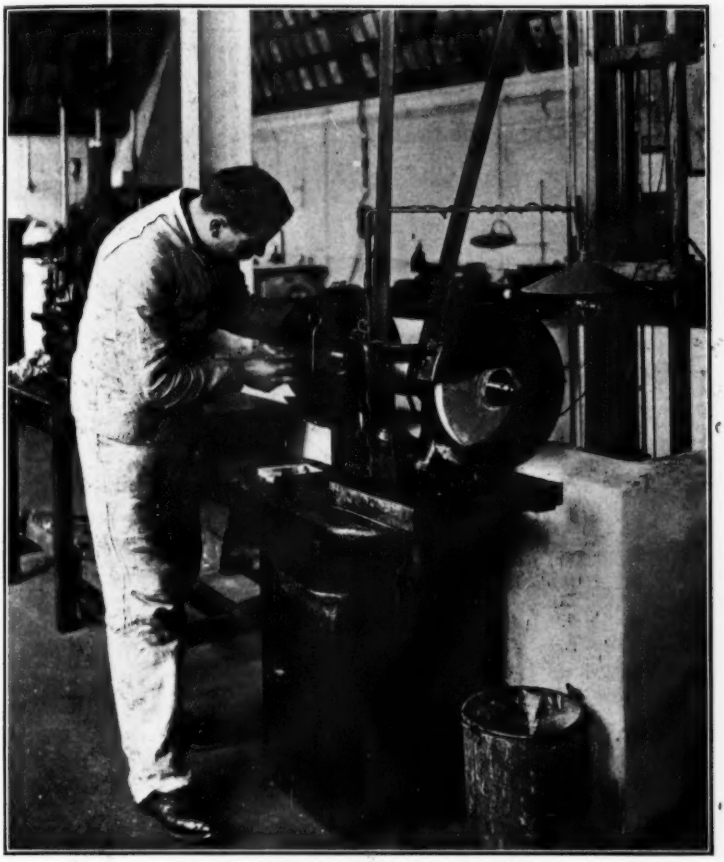
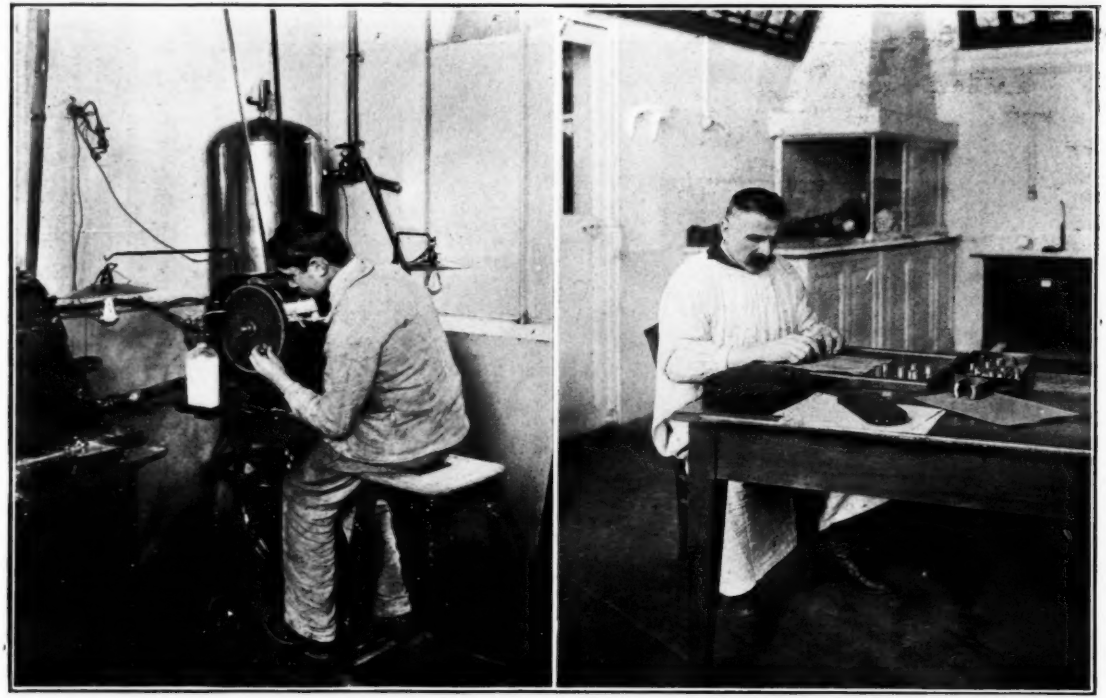


FIG. I. ROUGHING DOWN THE SPECIMEN.

grindstones. The next step is polishing, which includes roughing down, grinding with emery, and finishing.

Roughing down, which has for its object the dressing of the face to be observed, is generally done on an emery or carborundum stone, revolving at variable speed according to the metal which is under examination—800 to 1,000 revolutions a minute for soft steels, unhardened bronze and brass—in other words, for all alloys which are in such a state that slight heating is not objectionable. In other cases, especially for tempered steels, the speed of the wheel is lowered and it is kept thoroughly wet. The grindstones are mounted on a



FIGS. 2 AND 3. ON THE LEFT, A CORNER OF THE SPECIMEN-FINISHING ROOM AT THE DE DION-BOUTON WORKS, PUTEAUX. ON THE RIGHT, RUBBING ROUGHED DOWN SPECIMENS ON EMERY PAPER TO GET RID OF THE HARDENED SKIN.

In Figure 2 the vaporizer containing the alumina in suspension in water may be seen behind the wheel.

frame and operated by foot power or mechanically, as shown in the illustration on page 655 (Figure 1). In order to avoid a deep hardening effect, the metal must not be pressed too hard against the face of the stone, and according to M. Henry Le Chatelier, in order to avoid the slightest inaccuracy of result, the skin which is formed should be removed; this is done by rubbing the roughed-down samples by hand or coarse emery. (Figure 3). Last comes finishing (Figure 2) which depends for its success almost entirely upon the care given to the preparation of the materials used in this final polishing operation. As it is necessary to use powders with grains of very uniform size, and as these are not found in commerce, they must be specially prepared. Ammonia-alum is pulverized and calcined. The alumina thus obtained is ground in a mortar to break up the lumps which have formed. It is then washed several times with an 0.001 to 1 solution of nitric acid, next with distilled water, and finally with water to which one or two cubic centimetres of ammonia per litre have been added. In this way the various salts, especially carbonate and sulphate of lime, which might be precipitated with the alumina, are removed, and if a slight excess of nitric acid remains it is neutralized. This being done, the alumina suspended in water is put into a receptacle of one or two litres capacity; it is allowed to rest a certain time and the large grains which are precipitated are rejected, the supernatant liquor being siphoned off. This is allowed to rest successively for two hours, four hours, etc., and at the end of each period the liquor is siphoned off, while the corresponding precipitates are carefully preserved separate, each one being finer than the preceding, as the number of decantations increases.

Le Chatelier has designed an apparatus for more rapid preparation, which is worthy of notice. Commercial two-minute emery is sifted through 150 mesh and then through 200 mesh, and that portion is collected which passes the first screen and remains upon the second. For the finer polishing powder or putty the finest grade of commercial emery (60 to 120) is washed by an ascending current of water with a speed of about one millimetre per second, and the portions which are carried off by the current are collected for use. The designer has invented also a special apparatus suited to the practical conduct of this process.

The polishing materials being secured, let us pass to their mode of utilization in the finishing process. This is simply a polishing with alumina, conducted upon rapidly-revolving discs. Those used in

ordinary shop laboratories are made of thoroughly seasoned wood, covered with a flat disc of zinc, over which thick cloth is stretched. The polishing is begun with two-hour alumina, followed by four-hour, and if necessary with still finer grades. In this work, as one of the illustrations shows (Figure 2), the alumina is suspended in water in a spraying apparatus, and an excellent distribution of the polishing powder is thus secured.

In the de Dion-Bouton establishment one room is given up exclusively to the finishing operation; the roughing down and the rubbing with emery paper are performed in another laboratory so as to avoid the danger of carrying grains of emery over on to the polishing cloth mills. Under each one of these (four in number, working with different finenesses of alumina) is a good-sized water reservoir for the collection of the powder which is produced. Furthermore, the floor of the room is oiled, the walls specially coated, and the only one who enters the room is the workman who does the polishing. A compressor serving all the shops supplies the air necessary for operating the sprays.

Thanks to this installation, samples of steel are polished in ten minutes, and copper alloys in twenty minutes for the harder, and about thirty minutes for the softer, types. Occasionally, however, more difficult cases of polishing arise. Wires of small-cross section are inserted in a clamp of fair size and the whole thing polished together, or they are enclosed in some alloy melting at a low temperature and the entire face is polished. A metal shaving is examined in the same manner. It is placed flat in an alloy which is softened by gentle heating.

The polishing completed, the sample is next attacked by appropriate reagents which differ widely both as to composition and concentration according to the substance to be studied. After this, it is submitted to the microscopic examination. We need not discuss the older, well-known forms of apparatus—Cornu, Charpy, Nachet and Zeiss—but we shall consider only the Le Chatelier microscope which has found so wide practical application in metallography.

Reversing the ordinary arrangement, the objective is directed upward, which permits the examination of large objects and especially makes a single plane surface suffice for the examination of an ordinary sample. This is placed directly upon a support, replacing the stage of the microscope. The disposition dispenses at once both with the regulation necessary in the ordinary form of microscope to bring the surface to be examined exactly normal to the axis, and also with

the still greater task of preparing a sample with two plane and parallel faces. An important economy of time is thus secured.

The eye-piece, O (Figure 4), is placed horizontally on one side and receives the image through a total-reflection prism placed below the objective and above the screw P by which it is adjusted. The examination is thus carried on easily while the operator is seated before a table. Focusing is effected by means of the screw-threaded plate V which surrounds the objective and carries the support E. Its face must be absolutely perpendicular to the axis of the objective. The support is carried upon three points, carefully adjusted to exact height so as to insure the true position of the sample. For work demanding the highest precision a special stage is devised by which a series of successive photographic negatives may be obtained from the same sample. This stage (Figure 5) replaces the screw-threaded plate V. It is composed of three carriages of which two, b and c, move at right angles to each other. Their travel is about 20 millimetres and is measurable by a vernier scale; a third movement of revolution controlled by the knob a is also measured on a vernier. It permits the sample to be revolved about its own axis.

FIG. 4. THE LATEST FORM OF THE LE CHATELIER MICROSCOPE.

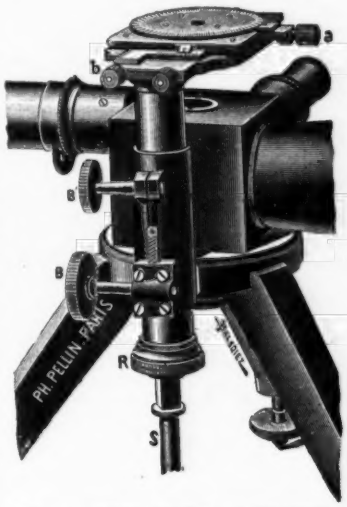


FIG. 5. STAGE OF THE LE CHATELIER MICROSCOPE.

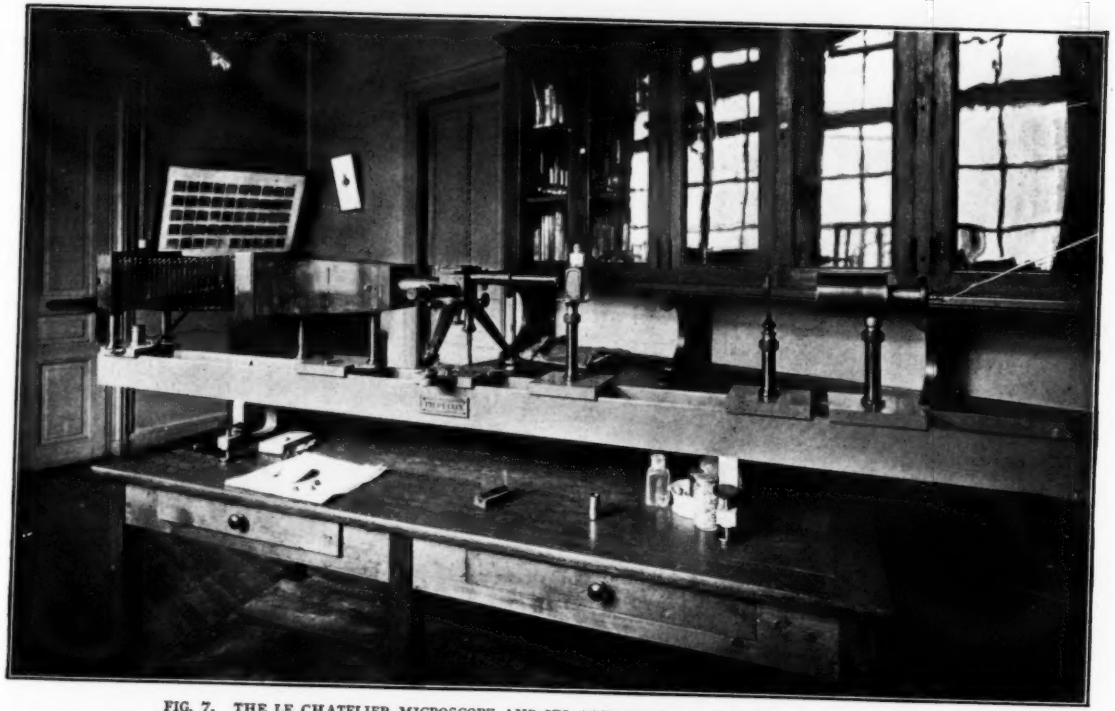


FIG. 7. THE LE CHATELIER MICROSCOPE AND ITS ACCESSORIES MOUNTED ON A METAL BED.
Photographed by M. Boyer in Le Chatelier's laboratory at the Sorbonne, by special permission.

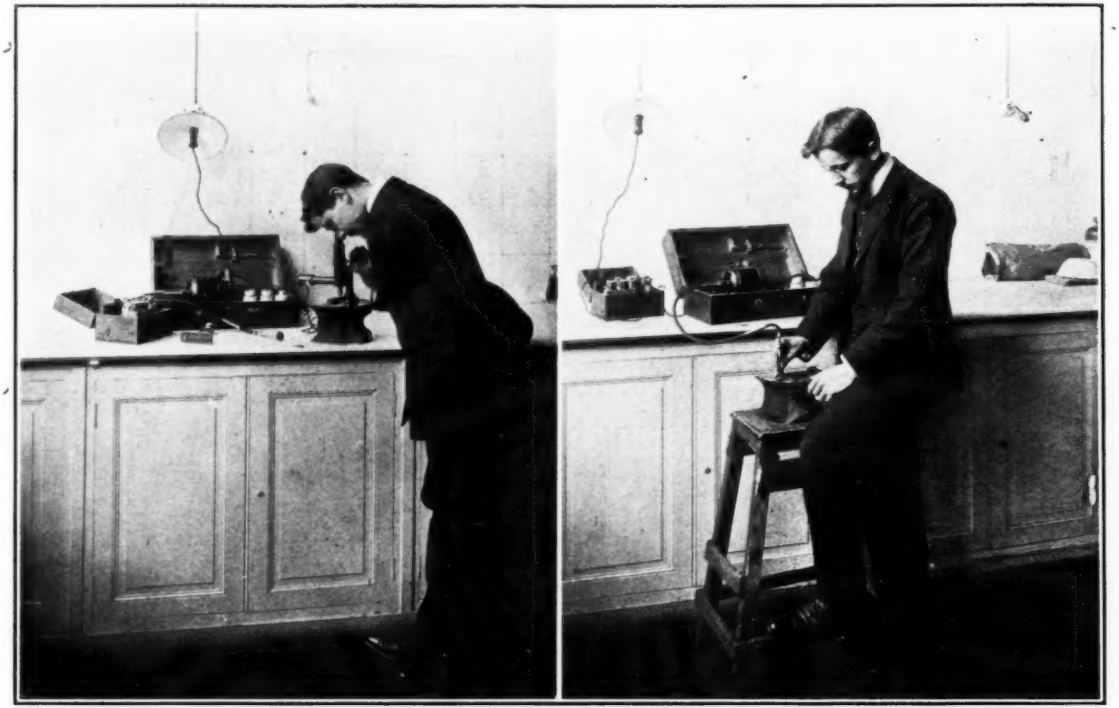
Focusing is accomplished by the three movements; a rack and pinion B serves for the rapid adjustment; a fine micrometer movement R accomplishes the exact focusing; finally, a flexible shaft S attached to the fine adjustment serves for focusing from a distance when the operator is using the camera.

In microscopic work on metals, however, lighting is the most delicate matter to regulate. Generally, this regulation is secured by trial, using a large number of movable pieces. M. Le Chatelier has sought to reduce this experimental effort to a minimum and to give to each element an exactly determinable effect. These elements are two—variable opening and variable position of a single diaphragm D which is so placed that:—

FIG. 6. A SMALL SHOP INSTALLATION OF THE LE CHATELIER MICROSCOPE APPARATUS.

1.—The opening of the diaphragm controls the angle of the luminous beam which falls upon each point of the sample. This angle must vary with the nature and quality of the objective, as in the case of photography. The larger the angle the more the influence of spherical aberration is felt; on the other hand, the smaller the angle the more will diffraction fringes tend to develop. The greatest clearness is obtained by a certain mean, which must be regulated in each case by experiment.

2.—The position of the diaphragm controls the average inclination at which the beam falls upon the sample. For clearness alone this



FIGS. 8 AND 9. ON THE LEFT, METALLOGRAPHIC EXAMINATION WITH THE LÉON GUILLET OUTFIT. ON THE RIGHT, POLISHING A LARGE SPECIMEN WITH THE SMALL EMERY WHEEL OF THE LÉON GUILLET OUTFIT.

direction should approach normal, but it is necessary to depart from this in order to reduce the amount of the light reflected by lenses to the eye of the observer. At a proper inclination the major part of the light thus diffused may be stopped by the collecting prism itself.

The diaphragm D (Figure 4) is placed at the front of the lighting system composed of a lens and the collecting prism. It throws its image upon the rear face of this latter. Beyond this, a second diaphragm cuts off the rays other than those which fall upon the test specimen under examination.

Accurate reproduction of the micrographic image, however, requires that it be preserved photographically. The Le Chatelier apparatus has been studied particularly with this object in view, and presents advantages over the Nachet and Martens apparatus, having now become almost the only form employed by French metallurgists. The latest type of this microscope, which M. Le Chatelier himself courteously permitted me to photograph in his laboratory at the Sorbonne (Figure 7) is mounted on a metal bench so as to secure great stability. The ensemble consists of a Nernst lamp, a bulb or flask for absorbing certain rays, a lens, and the microscope proper. An incandescent lamp suffices as a source of light for general observation, but for photography it is better to use a two-filament Nernst lamp, which permits relatively short exposure.

Unfortunately, this apparatus lends itself but ill to the examination of large finished parts and still less to machinery fully mounted. M. Léon Guillet, the distinguished professor of metallurgy at the Conservatoire des Arts et Métiers, Paris, has therefore designed a metallographic outfit particularly for inspectors, for expert examinations, for tests in place—for example, the inspection of ingots, the rapid verification of large metal mirrors, of automobile chassis, of machine frames, or for studies such as that of the breakage of a line shaft or of the proportion of copper in brass parts, etc. As shown in the illustrations (Figures 8 and 9) this apparatus consists of:—first, a continuous-current motor revolving at high speed, and a flexible shaft upon which the polishing mill is carried; second, files, emery paper of proper fineness, a box of reagents, hand-operated sprays for alumina, and two object glasses; third, the microscope, which is vertical and arranged so that it may be fixed very easily upon any object either by a screw clamp or by leather bands. The lighting for this microscope is obtained by a system similar to that used in the Le Chatelier apparatus, but the lamp is carried upon the apparatus itself. To this outfit is added a microscope stage with two movements, which

may be fixed upon the lower support when laboratory observations are to be made.

Thanks to the perfection obtainable in all the instruments of observation, metallographic manipulations can now be conducted with great ease in French industrial establishments.

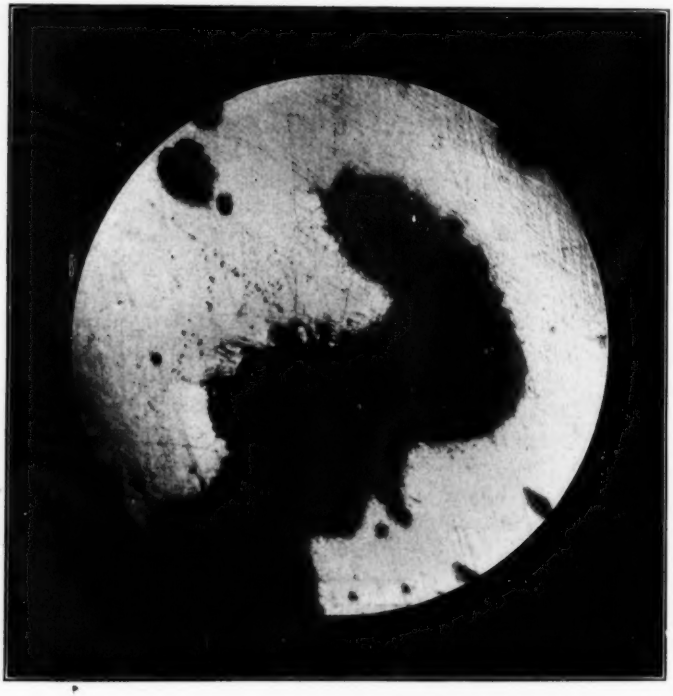


FIG. 10. SLAG IN IRON IN AN UNETCHED SPECIMEN.

General Applications.—This method of examination may sometimes be substituted for chemical analysis, and it often discloses, even before attack, little cavities invisible to the naked eye, but destructive to the quality of the product. (Figure 10). It determines the heat treatment to which the metal has been subject and that which it should undergo to secure the maximum efficiency. Before, or at times after, the attack, the sample will discover the presence of constituents different from those met with in similar products of good quality. From this an abnormal composition may be inferred, which may be further investigated, perhaps directly by metallography, or in

other cases by chemical analysis. We find a very striking example of this sort in the disclosure of the presence of oxide of copper in samples of copper.

The examination of the distribution of constituents and their relative importance gives most valuable indications which are furnished by no other method. Later, a large number of applications based upon this fact will be cited. In this connection attention will be drawn to the influence of rapidity of cooling upon the constitution of anti-friction metals, (Figure 11), certain bronzes and alloys containing lead, etc.

Finally, the metal will often show very distinct deformations, indicating the sort of mechanical treatment to which the mass has been subjected.

Let us now review rapidly the information which metallography may furnish concerning the principal metals of industry. So far as concerns the composition of cast iron, it defines:

1.—The approximate percentage of combined carbon; this is in the form of free cementite and of pearlite (ferrite-cementite eutectoid); attack by an alcoholic solution of picric acid will cause the pearlite to appear, while an attack by picrate of soda in soda solution will bring out the cementite in brown.

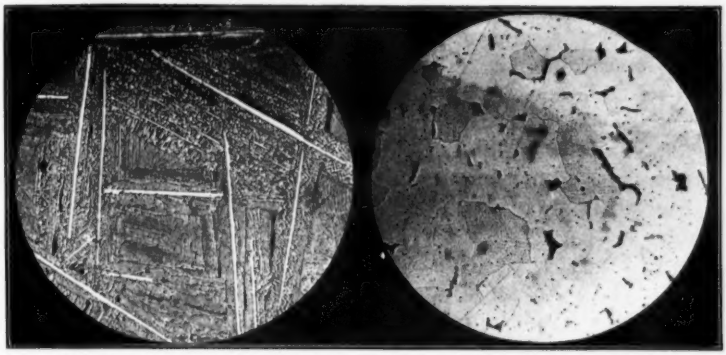
FIG. 11. ANTI-FRICTION METAL.
Magnified 48 diameters.

2.—The approximate percentage of graphite; graphite is visible after polishing and before any attack; the graphite and the annealing carbon are easily distinguished. (Figure 12).

3.—The approximate percentage of phosphorus. An acid solution leaves the phosphoric parts intact. M. Le Chatelier has remarked: "The classification of grey cast irons according to their phosphorus contents is extremely easy and rapid." In white cast iron (Figure 13) the distinction between the phosphoric parts and the cementite may still be made, although with a little more difficulty, by an energetic attack with nitric acid, which colors the cementite slightly, leaving the phosphoric parts uncolored.

FIG. 12. CAST IRON SHOWING CARBON AFTER ANNEALING.
Magnified 50 diameters.

4.—The approximate percentage of sulphur. This substance is in a state of yellow globules of sulphide of iron or of bluish crystals of sulphide of manganese. However, micrography does not permit estimation of silicon and manganese. Beyond this, metallography permits not only determination of the quality of malleable cast iron, so far as concerns the depth of decarburation and the temperature at which the operation was conducted, but it furnishes also exact knowledge concerning the heat treatment undergone. Thanks to it we may estimate with sufficient exactness the annealing carbon. This is



FIGS. 13 AND 14. ON THE LEFT, WHITE CAST IRON, SHOWING CONTRAST BETWEEN CEMENTITE AND PHOSPHORIC PARTS. ON THE RIGHT, A 0.05 PER CENT. CARBON STEEL ETCHED WITH PICRIC ACID.

Magnified 133 diameters.

present in round black globules which cannot be confounded with the lamellar graphite. The annealing of castings is a frequent operation, designed to produce softening; nothing is easier than to determine in any piece—the roll of a rolling mill for instance—the depth to which the temper extends, often an item of capital importance.

The services which this new method of procedure may render in the chemical or thermic treatment of common steels are of great importance and could not be secured by any other mode of examination. (Figure 14). For steels to be case-hardened, micrography, among other things, permits us to determine in advance and also upon finished pieces whether the steel employed is suitably low in carbon; to determine after case-hardening and before tempering the exact depth of the cementation layer; to ascertain before tempering the quality of this surface, which should contain about 0.85 per cent. of carbon, but should show no needles of cementite; and to define with ease the quality of the final product after tempering. The surface should then show a composition of very fine martensite and should not enclose needles of cementite or troostite (Figure 15). For tempered steels metallography gives the composition of the piece in its various parts, shows the depth to which the temper has gone (the martensitic layer), indicates whether or not the tempering heat was right (martensite should be imperceptible in hard steels). For annealed steels the micro-structure indicates if the annealing was well done (the temperature sufficient, but not too high); if the cooling was conducted under proper conditions (sorbite or troostite are produced by rapid cooling, pearlite by slow cooling). When annealing has for its

purpose the removal of the effects of cold rolling or hammering, every trace of orientation in the structure should disappear. If it has for its purpose the removal of temper, martensite should be converted into pearlite.

In any case—and this is a capital point, which cannot be too strongly urged—when micrographic estimation of carbon in any iron or steel product is undertaken the metal should be annealed; otherwise we are likely to find troostite and above all sorbite if the steel has been rapidly cooled (as in rolled and hammered forms), and we might thus be led to estimations which are much too high.

Few French industries have been more aided by metallography than that of steel casting. Practically, carbon may be estimated within 0.05 per cent. micrographically. Attack by picric acid suffices to bring out the pearlite; by comparison with a fixed scale the percentage of carbon may be found (Figure 14). So far as concerns other information, silicon, manganese and phosphorus are dissolved in the ferrite; sulphur may sometimes be distinguished in the form of widely-dispersed yellow globules; among extraordinary constituents, oxides, sulphides and slag may be distinguished. So far as concerns the distribution of constituents, the pearlite should be noted with the greatest care; this is the principal point. In raw steel castings pearlite is always found in large and irregular masses; it is otherwise after heat treatment.

So far as porosity is concerned, careful examination in advance of any attack must be made for blow-holes, which in this material are of great importance. The best results will be obtained from heat treatment when the pearlite is as uniformly distributed as possible. We shall then be certain to have got rid of brittleness—if this is not due to incorrect composition, especially to too high a percentage of phosphorus.

In the examination of steels which have undergone mechanical treatment, as, for example, rolled, forged and drawn shapes, whether the inquiry be as to composition, the presence of abnormal constituents, or soundness, the same results may be obtained as in the case of cast steel; but here, so far as mechanical and heat treatments are concerned, we may deduce new conclusions:

1.—As to the temperature at which the metal was forged; exaggerated size of the grains of ferrite in mild steels, or a coarse arrangement of the pearlite and ferrite in semi-hard steels, will show if the metal was worked at too high a temperature, or if it is brittle. It is easy to restore it to a better condition—annealing at a tempera-

ture slightly above its highest transformation point will suffice; the overheated metal is regenerated. In the rare case of a metal being "burned" it is of course known that no treatment short of a new fusion will restore the quality. The condition may be recognized by the cavities which appear here and there in the place of pearlite, and by the large quantities of oxide present.

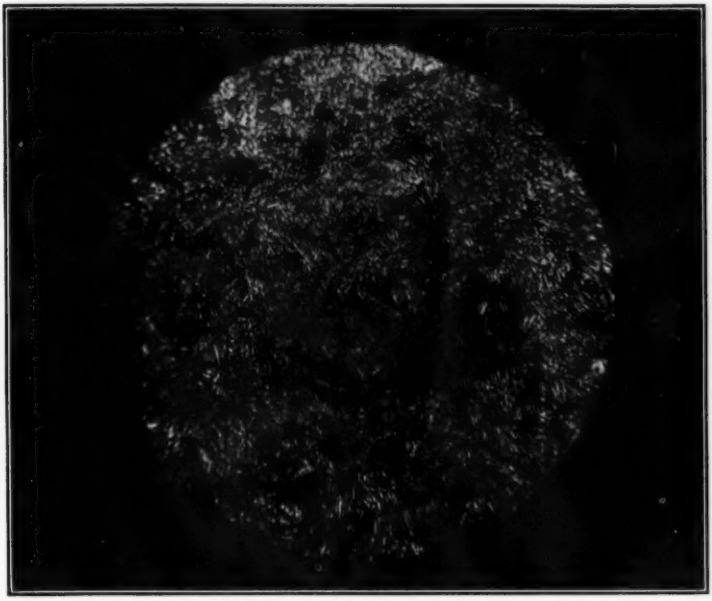


FIG. 15. FINE-GRAINED MARTENSITE ETCHED WITH PICRIC ACID.
Magnified 200 diameters.

2.—As to the finishing temperature of rolling; the great influence of this coefficient is well-known and has led to the design of some notable special machinery for rolling rails, especially in America. According to the investigations of various savants, particularly Stead, it seems especially advantageous to secure a troostitic structure characteristic of steels slowly tempered. M. Guillet, after observation of a number of rails thus treated, believes rather that it is sorbite which is present. To obtain it, the rolling must be finished very little above the critical point, or, better still, within the critical interval. Micrographic examination permits us to discern very easily the structure which has been obtained, and consequently to regulate the process of manufacture so as to secure the desired end (Figure 16).

3.—As to the results of cold working, followed by heat treatments, micrography renders the utmost service. By it we are enabled to see the deformations to which the surface and deeper layers have been subjected. It exhibits the effects of rolling or fine drawing. It permits us to ascertain if the metal has been well annealed, if it has been overheated, etc.

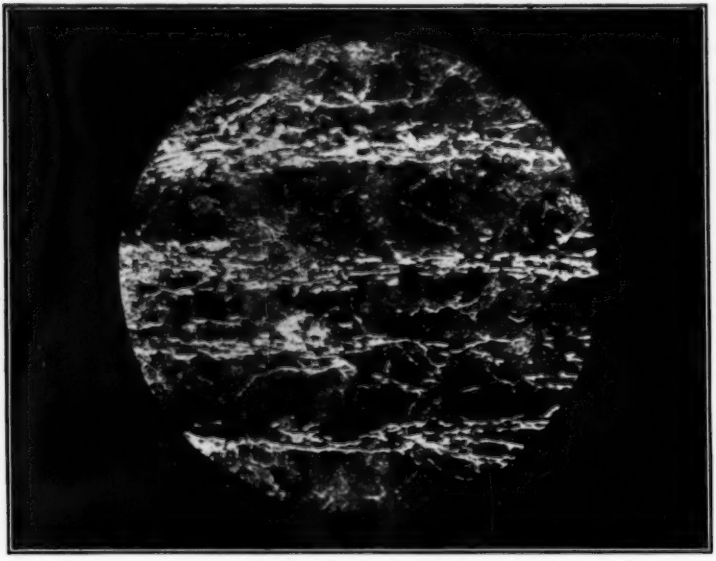
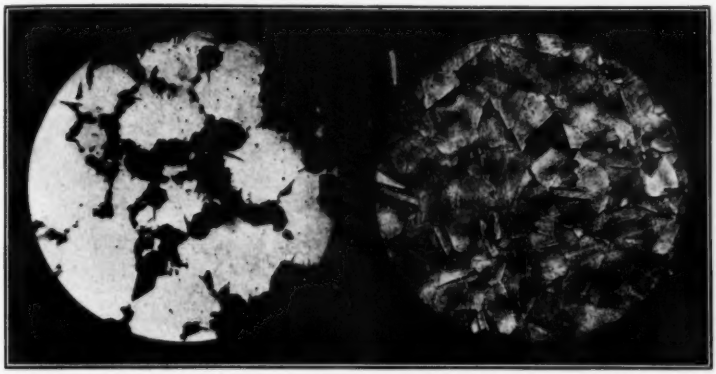


FIG. 16. A 2.20 PER CENT CARBON STEEL CUT IN THE DIRECTION OF ROLLING.
Magnified 200 diameters.

4.—Lastly, in the final product, the distribution of the constituents is often of considerable importance. For example, a steel plate showing pearlite in parallel bands will usually exhibit a high degree of brittleness. Microscopic metallography further finds useful application in the definition of special steels. The steels of commerce commonly met with, as is known, are structurally composed of pearlite with ferrite or cementite; of pearlite with a carbide other than cementite; of martensite or troostite; of troostite or sorbite with a carbide, or of γ iron. (Figures 17 and 18). It is easy to determine with which one of these steels we are dealing, and we may thus form practical conclusions because the properties of the several groups differ. It is to be noted that manufacturers have the extremely bad habit of designating a special steel by the percentage of some alloyed



FIGS. 17 AND 18. ON THE LEFT, TROOSTITE CRYSTALS (BLACK) IN A GROUND MASS OF MARTENSITE (WHITE). ON THE RIGHT, γ-IRON NICKEL STEEL.

Magnified 129 diameters.

constituent. They speak, for example, of a 2 per cent. nickel steel; now this does not describe anything; and if it is satisfactory to the producer it involves the consumer in the risk of mistake, but in such a case the microscope permits us to determine exactly the carbon contents, and, beyond this, the form of the pearlite and the size of the grain of the ferrite will furnish exact information. Thus, in nickel steels well annealed, we shall always find pearlite very finely grained; in chrome and silicon steels the grain of the ferrite is extremely fine.

When we have to deal with a steel which is close to the limit between pearlitic and martensitic it is impossible to obtain precise results; in fact the carbon contents deduced from the pearlite observed under the microscope do not in general represent the total. A certain proportion is in solution. Nevertheless, we may determine whether or not the steel is safe, for if it is not entirely homogeneous there will be extremely hard spots difficult to work or perhaps almost impossible to machine. Furthermore, as concerns homogeneity of these steels close to the limit, the microscope frequently permits us to define regions which belong wholly within a certain zone. Another example is still more interesting; when nickel steels for case hardening first appeared, of which the commonest type contains 0.12 per cent. of carbon, with 2 per cent. of nickel, shops in which these steels were worked found parts very clearly outlined in which tools would cut with extraordinary facility. Microscopic examination showed plainly the presence of nodules very high in nickel.

In the matter of heat treatment, to cite only the very important case of tool steel, microscopic examination permits us to determine the best temperature for tempering. Also it makes possible the comparison between two treatments of the same steel; in the treatment of double-carbide steels it permits us to see if all the carbon has entirely disappeared, and it fixes, also, the hardening temperature and the time of heating before tempering, which, as is well known, is of much importance.

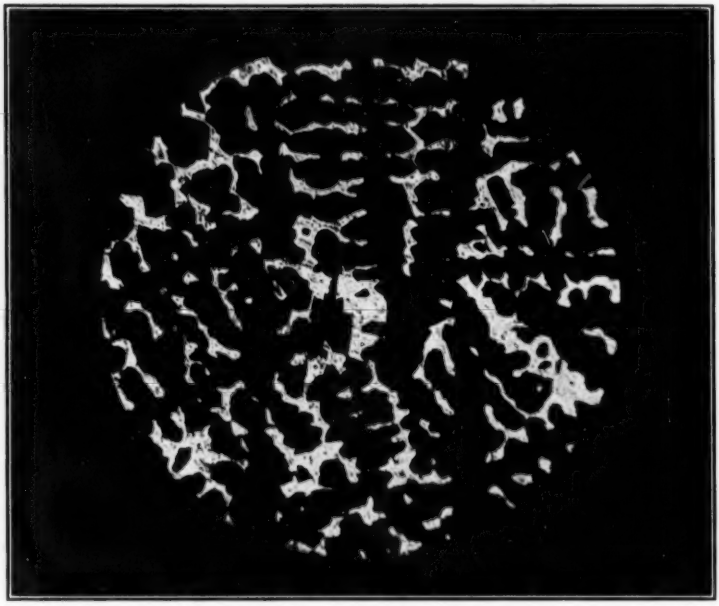


FIG. 19. BRONZE, 16 PER CENT. TIN. THE DARK AREAS REPRESENT THE SOLUTION α AND THE WHITE THE CONSTITUENT δ.

Magnified 200 diameters.

In French foundries working in common bronze (alloys of copper and tin) metallography is now used as follows:

1.—To replace up to a certain point chemical analysis, at least for bronzes containing more than 8 per cent. of tin. These are substantially after slow cooling, composed of two solid solutions (the constituents α and δ of Heycock and Neuville) in proportions which permit us to recognize the composition. (Figure 19).

2.—To know whether the alloy contains foreign substances. Notably we may recognize the presence of oxides which, according to the

investigations of Heyn and Bauer, will be stannic acid. This observation permits us to determine whether the metal has been deoxidized by addition of phosphorus, silicon, etc.

Sometimes we may recognize the presence of an excess of phosphorus. In this connection we should direct attention to the method of attack by picrate of soda which was first employed by M. Le Grix. He showed that the normal constituent of bronzes colors brown under the action of picrate of soda, the solution becomes yellowish, and finally the special constituent due to the presence of phosphorus remains very clean white. It appears further that this constituent is very undesirable; a phosphor-bronze well made should show only traces of it.

3.—To determine the homogeneity of the product. This is of much importance in hard-wearing bronze. It often happens that an important segregation of compounds occurs at certain points in the mass of the metal. Reheating at about 700 degrees will suffice to make the metal more homogeneous.

4.—To determine the heat treatment to which the alloy has been subjected and whether this has been proper. Thanks to the admirable memoirs of Heycock and Neuville, the considerable importance of the speed of cooling upon copper-tin alloys is recognized. It is therefore important to determine whether an alloy has indeed the normal constitution after pouring. For example, for a hard-wearing bronze the important constituent is the δ solution; this solution disappears wholly or in part upon rapid cooling.

Rolled or hammered bronzes under the microscope yield very interesting information beyond that indicated above in connection with cast bronzes. This relates to the manner of the heat treatment—temperature, speed of cooling, etc. A single instance may be cited. The rolling of bronzes containing less than 8 per cent. of tin (composed of the α solution) is accomplished in the cold and consequently is accompanied by many annealings. Before annealing the α solution is heterogeneous. Attack by perchloride of iron in hydrochloric-acid solution produces the appearance of spots, some darker than others. These are the parts richest in tin. Annealing makes the solid solution homogeneous. It then forms polyhedra of remarkable distinctness, and of size which is in some degree proportional to the annealing temperature. M. Guillet, who has studied this phenomenon (already noted in the case of brass by M. Charpy) has formulated the following principle: the annealing of every solid solution produces polyhedra very clearly marked, whose dimensions

are in relation with the annealing temperature. Now it is known that there is a very close connection between the mechanical properties and the dimensions of these polyhedra. When these are large we find simultaneous lowering of the breaking strength and of the elongation. The metal is said to be "overheated." When the metal is "burned" in the true sense of the word—that is to say, oxidized—we see round grains of oxide formed between the polyhedra.

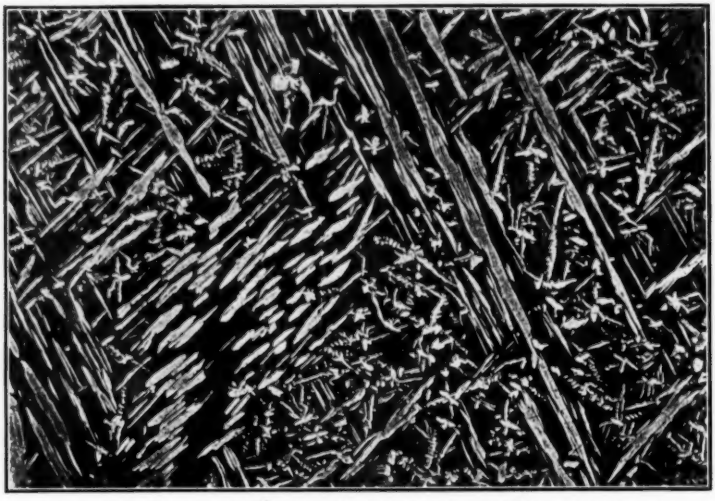


FIG. 20. BRASS, WITH 56.5 PER CENT COPPER AND 43.5 PER CENT ZINC.
Magnified 50 diameters.

Rolled, forged and hammered brasses afford opportunity for an extremely important utilization of micrography. (Figure 20). We know that the alloys of copper and zinc are divided into two distinct categories from the point of view of forging: 1, brass containing 55 to 62 per cent. of copper which may be forged hot; 2, brass containing from 60 to 100 per cent. of copper which is forged cold. There are a few alloys containing from 60 to 62 per cent. of copper, which may be forged either hot or cold. It should be added that alloys containing more than 90 per cent. of copper, if they are very pure, may be rolled hot. Evidently it is very important when, for example, we are casting an ingot which is to be hot-rolled, to know if it actually possesses the desired composition. A simple micrographic examination, without any injury to the ingot, will inform us if the analysis is actually between 55 and 62 per cent. of copper.

As in the case of bronzes, examination of the micro-structure also determines the character of the annealing and indicates the presence of foreign substances. In brasses containing more than 63 per cent. of copper we shall find polyhedra of dimensions dependent always on the conditions of annealing and rolling. We may also draw conclusions similar to those defined above for steel so far as concerns drawn shapes.

In the case of other alloys of copper, metallographic examination will furnish no less useful indications. In copper-nickel alloys consisting of a single solid solution, in copper-zinc-nickel compounds, and in alloys of copper and phosphorus, much employed in the foundry, we may easily fix the percentages by the proportions of the eutectic and the components.

Micrographic methods also replace chemical analysis advantageously and with sufficient closeness of approximation in such alloys as those of lead and antimony, employed for bullets, for accumulator plates, and anti-friction metals; of lead and tin (solder); and of silver and copper used for coin and plate. It is particularly important for anti-friction metals, of which the principal are composed of a complex crystalline eutectic of the combination Sb Sn, and needles of the combination Cu_6Sn. According to the quickness of the cooling very different results are obtained. The crystals are much more strongly developed as the cooling is slower. It appears that the crystals resist wear while the eutectic gives to the alloy the indispensable plasticity. In the ordinary processes of manufacture, anti-frictions are cast, usually in metal moulds; their constitution and consequently their efficiency depend essentially upon this casting, and micrography alone enables us to determine the conditions. Further observation of the micro-structure informs us as to the homogeneity of the product. Traces of copper (1 per cent.) suffice to render a lead-tin-antimony alloy extremely homogeneous.

Finally, microscopic metallography no doubt will soon permit fuller examination of the metals of industry, but French engineers still await the co-ordination of results already obtained to decide upon this practical utilization.

In conclusion, it should be conceded that the new processes complete most usefully the knowledge supplied by chemical analysis or by mechanical tests, but can not supplant all the other methods of examination, either in the laboratory or in the shop.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

VII. THE LOCATION AND ELIMINATION OF WASTES.

The parts of Mr. Emerson's series, which began in our issue for July last, already presented have discussed the world-wide evils of inefficiency in almost every branch of human activity; the peculiar national qualities which have thus far helped the leading industrial nations to mitigate the losses due to inefficiency; the necessity for supplementing the line system of organization on which industrial management principally depends with modern staff organization; the relation of standards to organization and to results; and the realization of standards in practice.

Last month, under the heading "The Modern Theory of Cost Accounting," Mr. Emerson laid the foundation of the proposition he completes in the following pages. This is that actual costs must be subdivided into standard costs and preventable wastes; that standard costs must be based on full equivalency in service rendered for money spent; that standard costs must always be predetermined; that average wastes are part of general expense and can be currently anticipated; that the chief duty of the operator is the maintenance of all standards; and that cost standards can only be attained through methods, records, ideals and checks furnished jointly by the comptroller and the efficiency engineer to the executive line officials.—THE EDITORS.

MODERN efficiency cost accounting and expense statements consider separately *actual expenses,* which concern chiefly the comptroller, *efficiency costs,* which concern alone the efficiency engineer, and *allotted costs,* which concern both comptroller and efficiency engineer. Actual expenses need no definition. Efficiency costs are predetermined expenses with the differences added or subtracted to balance actual expenses. Allotted costs are separated into two items, both predetermined, namely, standard cost and current waste. Allotted costs are therefore also predetermined. It is part of the duty of an efficiency engineer to predetermine standard costs either by using existing standards or by a series of assays.

Current wastes are predetermined by assuming that they will be relatively of the same percentage as for an immediately preceding period. The period may be either short or long—a week, a month, a quarter, a year or a longer term. The more rapidly changes occur, the shorter should be the term, but when operations are well standardized and standards regularly attained the term may be longer. Allotted costs are based on two predetermined items, standard costs and current *percentage* of waste.

Standard costs are the mariner's compass of a business enterprise,

showing as they do from month to month the proper course of the business ship. Predetermined costs, which include prevailing waste, are knowledge of the latitude and longitude of the location of the ship. Predetermined costs, although of immense practical value, are subject to one slight disadvantage more theoretical than actual which may, nevertheless, prejudice adherents of the old school against the new methods. The drawback is that predetermined costs do not agree with actual expenses over the same period. Let it be remembered, however, that this lack of agreement is no more important than is the lack of agreement (except at two moments of the year) between sidereal time and sun time, the lack of agreement between standard railroad time and local clock time, the non-agreement between magnetic north and true north, the non-agreement of the pole star with the true north, or the non-existence of any constant true north since even the axis of the earth wabbles.

The efficiency engineer needs statements of standard costs, of current wastes, and of predetermined costs, and he needs also a statement of efficiency expenses. Without them he is in the position of a driver who is trying to develop a trotting horse without the advantage of a measured course or of a time piece. The driver would accomplish something, he might indeed force the horse to the limit, but he would never know whether he really had the best horse, or whether some change of harness, shoes, sulky or track was a betterment or a detriment. The efficiency engineer knows that only by the rarest accident will actual costs correspond with allotted costs, which are the sum of standard cost and previous waste percentage. He will never attain exact correspondence between allotment and performance. The comptroller's problem is to reconcile the actual expenses, for whose correct statement he alone is responsible, with the practically valuable and useful allotted costs which he and the efficiency engineer have jointly elaborated and accepted; it is also his task either to maintain for the efficiency engineer, or to assist him in securing, records showing the discrepancies between allotted and actual costs. He can of course adjust allotted costs to actual expenses or he can adjust actual expenses to allotted costs. It is more desirable to do the latter, because in no other way is the attention of all concerned continually called to the important facts of standards and of wastes. A railroad which reports locomotive repair costs of $0.16 per mile, a fact whose importance escapes all but a very few experts, would not be so indifferent to this very great waste if it had to report in the form illustrated at the top of the next page:—

Miles run	30,000,000
Standard cost for repairs per mile	$0.06
Total standard cost	$1,800,000
Preventable waste and repair cost per mile	$0.10
Total cost of preventable waste	$3,000,000
Total actual expense per mile	$0.16
Total actual expense	$4,800,000

Efficiency engineers have also found to their sorrow that unless allotted costs are tied in to current costs by the comptroller it is impossible to attain accuracy in their statement, and there is also no available proof to convince those on whose support they must rely that the methods used are really producing the results promised. On one occasion I discovered that payment for a cow accidentally killed has been charged to the tool-maintenance account, not for the purpose of perpetrating a fraud but simply to close out an omitted item. When the tool account was put on standard allowance, items of this kind sought refuge elsewhere, and the expenses reported were those actually incurred. The old ideals of close time accuracy in the statement of costs are not to be lightly disregarded, but hitherto they have resulted in obscuring the importance, and caused the neglect, of items more important from the profit and loss, from the efficiency aspect. If a worker is overpaid through an error in his rate, if he draws pay for a day on which he is not present, there is quite proper alarm and no hesitancy is shown in correcting the error during the next pay period; but if the same workman destroys valuable material or continuously kills time, no one except perhaps his foreman takes any cognizance of the resulting loss, which in the aggregate probably exceeds a thousandfold the loss due to accounting carelessness. Inaccuracies in money should not receive less attention than hitherto, but efficiency losses should receive more. If a slight time inaccuracy in expense statement results in very great efficiency and other gain, knowing full well what the inaccuracy is, its amount and why it has occurred, we can accept it just as we accept the magnetic compass or the pole star as preferable to the imaginary true north, or standardized sidereal time as preferable to the practically impossible sun time. There is the great gain of continuous efficiency statement, of anticipation of all cost records, so that the cost of any particular operation, however extensive or minute, is known in advance with greater real accuracy as to single items than in the system of accidental costs, and with very small inaccuracy as to the total aggregated expenses of a year. To illustrate by a concrete example. It is better for a monthly or yearly report to state that allotted costs for repairs to locomotive per mile traveled are $0.07 when in reality they are $0.0696, than to

state them accurately as $0.101, when no one has any idea how they may be reduced.

The double problem and its solution by comptroller and by efficiency engineer will be shown by an actual practical example. On a great railroad system current actual costs of one of the items of locomotive repair were about $0.10 per unit. A reduction of this account was planned in June, 1904. It was definitely ascertained from the official records:—

1.—That actual expenses for the preceding year had been $487,171;

2.—That actual expenses per unit were $0.1031.

It was definitely stated by the efficiency engineers:—

1.—That standard costs per unit should not exceed $0.06;

2.—That current losses and wastes per unit were at least $0.04.

3.—That on the basis of same volume of business actual expenses should be reduced to $287,000;

4.—That the actual annual saving should be $200,000.

The double problem was to eliminate the inefficiency costs which amounted to 40 per cent of the whole expenses, and to reconcile predetermined costs with actual costs. The tables below and on page 680 illustrate the progress of the work from year to year, although actually the corrections would be made and standards revised from month to month, thus minimizing differences.

ALLOTTED COSTS, ACTUAL EXPENSES AND EFFICIENCY EXPENSES.

	1903-4	1904-5	1905-6	1906-7
Total units	4,725,000	4,785,000	5,776,000	6,462,800
Allotted standard costs	$283,500	$287,124	$336,560	$323,140
Allotted wastes	189,000	191,416	57,760	.....
Total allotted cost	$472,500	$478,540	$394,320	$323,140
Discrepancy between record and actual,—				
Increase	14,671	8,080	.....	.....
Decrease	.....	.....	18,214	7,296
Actual total expense as it appears in President's report	$487,171	$486,620	$376,106	$315,844
Amount forward,—				
Debit	.....	14,671	22,751	.....
Credit	.....	.....	.....	4,537
Efficiency expenses	$487,171	$501,291	$398,857	$320,381
Allotted cost	.....	$478,540	$394,320	$323,140
Debit forward	.....	14,671	22,751	4,537
Current deficit	.....	8,080	.....	.....
Current credit	.....	.....	$417,071	$327,677
Current credit	.....	.....	18,214	7,296
Efficiency expense statement	.....	$501,291	$398,857	$320,381

UNIT STATEMENT OF EXPENSES AND COSTS.

Total units	4,725,000	4,785,400	5,776,000	6,462,800
Allotted standard cost	$0.06	$0.06	$0.06	$0.05
Allotted wastes	0.04	0.04	0.01	....
Total allotted unit cost	$0.10	$0.10	$0.07	$0.05
Discrepancy,—				
Loss	0.0031	0.0016	....	....
Gain	....	....	0.01	0.002
Actual unit cost	$0.1031	$0.1016	$0.069	$0.048
Efficiency, per cent,—				
Assumed at year's beginning	60.	60.	85.7	100.
As shown at year's end	58.2	57.	87.	104.2
Increase of cost due to inefficiency, per cent,—				
Assumed at year's beginning	66.7	66.7	16.7	....
As shown at year's end	72.	74.	14.9	4*
Increase or decrease of cost, per cent,—				
Compared with original standard	3.1	1.6*	31.*	52*
Compared with current standard.	3.1	1.6	1.4*	4*

* Decrease.

In the year 1903-4, before efficiency work was begun, the actual costs were $487,171, but allotted on a basis of $0.10 they would have been $472,500. The difference between these two amounts could be either cleared at the end of a fiscal year, or, preferably from the efficiency standpoint, carried in the statement of the lapsed year 1903-4 to "Accounts Receivable" or to "Advances on Work not yet Performed" or to some other suitable caption; but at the beginning of the ensuing fiscal year it is charged immediately or in monthly instalments to the maintenance account under consideration. If this is done, in the year 1904-5 the allotted expenses appear as $478,540 but actually amount to $486,620 expended through the year, to which must be added the item of $14,671 brought forward as a charge from the preceding year. The deficit of $22,751 at the end of this year is closed out as before and is carried as an initial charge into the year 1905-6. For 1905-6 the standard cost is continued at $0.06 but, owing to the improvements already effected, wastes are allotted at $0.01, making a total allotted cost of $0.07 per unit. This totals to $394,320 but actual expenses are only $376,106, or $18,214 less than the allotment. The deficit at the beginning of the year was $22,751 from which we subtract the credit of $18,214 leaving a debit of $4,537 to be carried into the year 1906-7. For this year the standard cost was reduced from $0.06 to $0.05 per unit, and no allowance being made for wastes, which by this time were eliminated, the allotment was also reduced to $0.05. The total of allotted allowance was $323,140, the actual expenses were only $315,844, the forward charge was $4,537, making a total of $320,381. At the end of the year 1905-6 this ac-

count shows a credit balance of $2,759, the difference between allotment and actual expenses, and this amount can be reported under "Accounts Payable," or "Due for Work Already Done," or any other suitable caption.

It is much to have reduced the total actual cost from $487,171 to $315,844 but the real results attained are shown more clearly in the unit statement. Not only was a standard of $0.06, 40 per cent lower than current practice, adopted, but in the fourth year the standard was revised and a new standard of $0.05 adopted, which was more than attained in the following year. Not only was a waste of $0.04 predetermined but a waste of $0.052 per unit was actually eliminated. The unit expense was reduced more than one-half and the end of improvement was not yet reached. The handling of this account on an efficiency basis of predetermined costs yielded many other instructive experiences. The original computations were made in June, 1904, but July, August and part of September were allowed to slip by before work was seriously taken up. By this time the monthly expenses had risen to $45,129, the unit cost approximating $0.114. There were no sub-records of details available so that the efficiency staff did not know where to begin its work, and the process of betterment required large initial outlays for better facilities, tools and equipment. The cost of making up a complete set of sub-records was considerable. As a consequence the first half of the fiscal year 1904-5 cost $256,891, the unit cost being $0.1073. The detailed records for each month show the tremendous efforts made to stem the rising tide of waste during this first year, but the annual record does not show this internal struggle. Possibly some will claim that the reduction of expense was not due to efficiency standards and efficiency methods. Perhaps not; but the diagnosis of inefficiency was made before beginning any work, standards of cost and waste were established before beginning any work, a large staff using drastic modern methods was exceedingly busy trying to produce results through every means known to efficiency engineers, and where this staff was most active the greatest improvement was attained. On a similar and parallel road, all conditions being closely identical, except efficiency staff, during the same three years actual costs hovered around the unit cost of $0.10.

	A.—Using Efficiency Staff Organization.			B.—Without Efficiency Staff Organization.		
Year.	Output.	Expense.	Unit Cost.	Output.	Expense.	Unit Cost.
1903-4..	47,250	$487,171	$10.31	51,003	$487,150	$9.55
1904-5..	47,854	486,620	10.16	52,037	567,161	10.90
1905-6..	57,760	376,106	6.51	57,034	537,318	9.42
1906-7..	64,628	315,844	4.89	65,076	638,193	9.81

In modern railroad operation an account aggregating less than $500,000, is not of highest importance. The example given has been selected to illustrate methods rather than the results in details. During the same period on the same railroad and in wholly similar manner another account was standardized and reduced as follows:—

	1904-5	1905-6	1906-7
Total units	47,854	57,760	64,628
Standard labor cost per unit	$30.	$31.35*	$32.10*
Standard waste per unit	40.	20.	10.
Allotted cost per unit	$70.00	$51.35	$42.10
Actual expenses per unit	70.15	48.57	43.32

* The weight of units increased.

As to this account the reduction in waste attained on a unit basis amounted to $1,731,030. Smaller accounts were even more successfully handled. In one case the total actual expenses dropped from $12,000 to $500 with the same amount of work.

There are five trunk railroads operating between New York and a western point. Taking the locomotive mileage as a unit, four of them maintain their locomotives in repair approximately as follows:—

	A	B	C	D
Repair cost per locomotive mile	$0.04	$0.08	$0.12	$0.16

Those intimately familiar with conditions on C and D know that locomotives on these roads can be maintained in first-class repair for $0.06 per unit. Railroad C has a locomotive mileage of about 20,000,000, so that its excess of expenses owing to its inefficiency as to this one item is not less than $1,200,000 per annum. Railroad D has a locomotive mileage of 30,000,000 and its excess of expenses owing to its inefficiency as to this one item is not less than $3,000,000 per annum. The total locomotive mileage of all the railroads in the United States is about 2,000,000,000 and a saving of $0.04 per mile is possible on all but a very few. Hence the total waste per annum is about $80,000,000, or about the same as the total annual gold production in the United States—a waste and loss that a change from accounting by retrospect to accounting by anticipation would do very much to correct.

Let it not for a moment be assumed that Government management would result in less waste. Government work not of a scientific nature, eliminating also "star routes service" in which often a bow-legged, bare-headed child, riding on an antiquated mule, carries "The United States Mail," is generally carried on extremely inefficiently. In one of the largest operations conducted by the United States government the following assays were obtained, transcending anything ever revealed in railroad shops.

	Standard Cost.	Waste.	Actual Expense.
1.....	$1.95	$29.65	$31.60
2.....	2.60	13.65	16.25
3.....	6.50	39.00	45.50
4.....	1.30	14.95	16.25
5.....	3.90	35.10	39.00
6.....	13.00	85.00	98.00

Accountants will understand that so vague and unscientific a unit as "locomotive mile" has been used in the above example solely to illustrate a principle. The real standard unit of cost for any operation is the hour, to which in certain cases material costs are added. It costs so much a year to operate an industrial plant or a railroad; the year is subdivided into working hours which may vary in different departments. Every ordinary operation can be reduced to time at a definite cost per hour. The efficiency of any man, any machine, any department, any shop or division, or any plant or railroad can be determined by standard time and rate and the addition of the wastes to time and rates which previous experience revealed. The cost of repairing a particular locomotive for a particular mile run never has been, never can be, ascertained, but the rate of pay for a man for a given hour and his speed of work can be as definitely determined as the length of a race track and the time required by a horse to go around it. It is absurd to standardize the output of a locomotive plant at fifty locomotives a month when the standard labor on one locomotive amounts to 20,000 hours a month and on another locomotive to 5,000 hours. When, however, standard hours of labor for each item of each locomotive are summed into a total of standard hours for each type, then, if the limit does not lie in the machines, the number of men required (with allotted waste added) can be predetermined; or, if the limit of the machines determines the number of men, then the number of hours available fixes the volume of output, which may be high one month at forty locomotives and low another month at sixty of a different type. Costs of locomotives or of locomotive miles, or of track maintainance, or of anything else will take care of themselves when the unit hours of each man and machine are operating at highest efficiency for standard cost, and there is no other way to save millions of dollars than to avoid spending dimes without equivalency. The next essay will show how, on a very large scale, wastes of dimes were reduced.

EDITORIAL COMMENT

The Return to Normal.

RARELY, indeed, does a new year at its very outset hold out such assured promise as this year of 1909, that the good things we have will be steadily increased and multiplied, and that the end of the year will be far better than its beginning.

It is not necessary to demonstrate again here the soundness of the foundations on which this new extension of our industries is building. We need not recapitulate the unprecedented wealth of agriculture, the enormous crops to be moved, the postponed construction that must be resumed, the equipment demanding repair and renewal, the accumulation of money seeking occupation and growing impatient of longer delay.

It is not necessary to point out again that the drastic surgery of the past fifteen months has cut away the unhealthy and unsound parts of the older growth, and left only solid tissue, now healed and full of life and energy. It is, however, important to point out the great advantages which lie in a normal, deliberate increase in the scale of activity, such as the country is experiencing. The greatest danger of a period of resumption is that it may expand into a boom, with certain consequences of undiscriminating haste, unwise or ill-considered action, and resultant reactions more discouraging than the original check to prosperity.

The situation now is well illustrated by the remark recently made by an officer of a very large manufacturing corporation. He said in substance:

"We hope resumption will come gradually and not with a rush. You see our condition now—moderate activity, but a thoroughly sound and highly efficient organization. We have kept the best of everything—men, machines and methods—as a nucleus throughout the period of depression. If our new work comes in gradually we can build up correspondingly, choosing always the most desirable of all material offering; and thus we can keep our efficiency as high as it is now—far higher than it ever was before. If we are overwhelmed with a rush of business we must use all the labor, and any manufacturing policy we can get, to turn out the work. Our efficiency, our discipline, and our system will go to ruin, and the net results will be poorer than we should secure with a smaller volume of business kept under full control."

It seems possible, as already suggested in these columns, that one great and profitable result of the past depression will be closer attention to the attainment of efficiency in manufacturing. General conditions were forcing the issue. Special conditions, operating alike on employers and workmen, have shown by object lessons how much better we can do than we have been doing. The efficiency movement is likely to be one of the very important features of the era of prosperous activity upon which we are now entering.

For the development of this subject, THE ENGINEERING MAGAZINE has adopted the unusual course of sending an editorial representative on a trans-conti-

nental tour of examination, study and report. The results observed and the data secured are among the most interesting ever offered to a manufacturing constituency. Aside from their direct value for information and suggestion as to production methods, efficiency standards, and labor relations, they will have an important bearing upon some of the most pressing economic questions disturbing the public today. The series of articles in which these things will be described will begin in an early issue and will give the keynote of the tone of the Magazine for the year. To them will be gathered each month a record of the work and thought of industrial leaders and managers — the discussion of the best equipment, the best methods, the most advanced ideas for every part of the plant—information as to every device that will reduce friction, waste, and expense—instruction for wise use of the unusual opportunities now presented for the installation of new machinery, and for more effective work in standardizing and modernizing machinery and methods already in use. In brief, THE ENGINEERING MAGAZINE for 1909 will be a living handbook of efficiency and economy in industrial engineering and constructive enterprise in the shop, the factory, the power-plant, and the mine.

Legislation and Prosperity.

THE great desire that the situation shall be allowed to work itself out normally with the elements and forces so far set at work is voiced in many quarters, and the demand is likely to increase in volume and intensity. We must have time to digest that which has already been set before us, and must be spared for a time further prescription, lest our industrial dyspepsia become obstinate as well as violent. Legislation against abuses of the past has run riot, and many protests are raised against further legislation until at least certain of the recently passed laws can be thoroughly tested. A significant expression of this feeling is found in resolutions recently passed by the Illinois Manufacturers' Association requesting "all senators and representatives of Illinois in the national and State legislatures to discourage all measures having a tendency to continue or to aggravate the agitation against corporate interests, and to support all legislation which, without injury to their constituents, will tend to allay the hostility toward business conducted under corporate form, including manufacturing, commercial and transportation companies, while the new laws on the statute books are being tried out," and further urging "all municipal and civic bodies, corporations, transportation companies and individuals to refrain from any acts that will cause agitation or disturbance retarding the return of prosperity and favorable business conditions, to the end that in the resulting quiet, commercial and all other interests may have an opportunity to recover more quickly the golden days of prosperity heretofore enjoyed."

To this earnest exhortation there is a fervent chorus of Amens. It is therefore most unfortunate, in our judgment, that the open and official assumption of this attitude by important manufacturing bodies should have been followed almost immediately by concerted action on the part of the railways for the raising of freight rates. The economic argument against such an advance as a solution of the problem by which the roads profess to be embarrassed has heretofore been summarized in these columns. Unquestionably, the development of the demand for transportation facilities puts a constant burden upon the railroads for increased expenditure. Mr. John F. Wallace, in an address recently read before the Southern Commercial Congress, states the case ably:

"The railroad of today is no sooner completed as a single track, than it becomes necessary to provide industrial spurs; additional or enlarged terminals; replace its

temporary structures by permanent ones; widen its excavations; strengthen its embankments; provide passing tracks, additional shop facilities, enlarged passenger and freight stations, warehouses, elevators, docks and wharves at water terminals, additional tracks, heavier rail, rock ballast, elimination of curves, reduction of grades, block signals, elimination of grade crossings, heavier engines, larger and better cars, to the end that the constantly growing requirements and exactions of modern traffic conditions may be met; all of which requires increased expenditures, which it is easily seen could not in any event be provided for out of earnings.

"The ability of railroads to construct these improvements, which are so essential to the future prosperity of the South, depends upon the willingness of capital to furnish the necessary funds for the purpose.

"While legislation may control and regulate the returns upon invested capital, there is no process by which it can compel that investment originally. While investment is easily retarded it is difficult to attract."

Nevertheless, a similar condition confronts every manufacturer whose business is expanding, and the constant outlay is justified and recouped by the larger profits drawn from the greater volume of business, and by the decreased cost of production attending the betterments. It can not be met in competitive industries by a horizontal raising of prices, and the disastrous result of resorting to an economic fallacy will be just as certain in the case of the railroads, although the working of the economic laws, on account of the different conditions, may be less immediately and directly evident.

Sources of Energy.

SOME interested readers of Mr. Warren's articles in our October and November numbers, especially of the latter, seem to have reached an incomplete understanding of his argument and have been inclined to criticise a supposed disregard of the energy balance in his proposition that hydrogen might be made available as a fuel. We believe Mr. Warren has not the least intention of overlooking the fact that the same amount of energy is required to break up a molecule of water as is liberated in its formation. His hypothesis is that some form of natural energy not capturable in other or more direct ways may be utilized in effecting this dissociation. One objector to Mr. Warren's hypothesis remarks that "the hydrogen in a drop of water, in so far as its value for the useful production of power is concerned, is in exactly the same position as the water in the bottom of the tail race in the hydraulic plant." This states the point admirably, and at the same time suggests Mr. Warren's reply, which is that Nature is continually raising and transporting that water in the bottom of the tail race in the form of vapor and precipitating it on high mountain slopes, thus returning it with its potential energy at the intake of the penstocks. We simply interpose our hydraulic machinery in a natural cycle, and recover a portion of the energy constantly exerted by that great source of terrestrial energy —the sun. Mr. Warren believes that in some similar manner we may interpose our combustion machinery in a natural (chemical) cycle of water dissociation and hydrogen liberation—a cycle shorter and more direct than that of plant growth and coal formation, which now gives us our carbon fuels by dissociation of carbonic acid. This solution may be remote; it may not even be very probable; but the concept is not contrary to the laws of thought nor the laws of chemistry and physics, and perhaps greater improbabilities have been realized.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE PUBLIC FUNCTION OF AN ENGINEERING SOCIETY.

A PLEA FOR A LARGER MEASURE OF CO-OPERATION BETWEEN THE SOCIETY AND THE GENERAL PUBLIC.

Morris L. Cooke—American Society of Mechanical Engineers.

AT the recent annual meeting of the American Society of Mechanical Engineers, Mr. Morris L. Cooke presented an interesting and effective plea for the adoption of methods to familiarize the public with the aims and ideals of the Society, and to make its work of direct benefit to the people. He believes that a number of present day conditions seem to demand a broadening of the lines of professional activity and he offered a specific recommendation as to the means by which the Society can strengthen the position of the mechanical engineer as a member of the community and place at his command powerful forces at present denied to him and yet absolutely necessary for the full accomplishment of his professional mission. Mr. Cooke's suggestions are worthy of careful consideration not only by the American Society of Mechanical Engineers, to whom they were primarily addressed, but by all other national societies; their fulfilment could hardly fail to be productive of great public good. We give a brief abstract of his paper.

"In the work of the engineer there are three parties interested, namely, the engineer, his employer and the public. While always recognizing the claim of this third party, engineers as a class have done little, directly, to satisfy it. The chief service rendered the public by the engineering profession has been one rendered indirectly by serving well the second party interested—the employer. The time is near at hand when in matters in which they are specially qualified engineers must, individually and collectively, labor for the public interest with just as much fidelity and zeal as they work for their employer, and this not as public spirited citizens but rather as members of a public spirited profession."

If the standing of the engineering profession is to grow in public esteem, it will be because of the effort of the profession to familiarize the public with its aims and ideals. There will probably be little protest against the conception of the engineer as the special conservator of the public interest in matters involving engineering. In the history of the Society many instances may be found where its members, individually or collectively, have departed from the professional groove to co-operate in some broad way with a section of the general public. But in the manifold activities of the Society the general public as such has been almost ignored. Among the hundreds of papers which have been read before the Society it is difficult to find a single title which indicates that the author was addressing anyone beyond his professional audience. Among laymen the Society is given full credit for its professional strength but absolutely none for interest in public matters; this is the public's estimate of technical organizations as a class.

The constitution states the object of the Society in such a way as to permit of an almost indefinite extension of function, but it imposes on the membership no duties except those of a purely professional interest. "The object of the Society," it says, "is to promote the arts and sciences connected with engineering and mechanical construction," and it specifies as the means to be used for this purpose "the holding of meetings for the reading and discussion of professional papers and for social intercourse, the publication and distribution of its papers and discussions, and the maintenance of an engineering library." The library may in the future be made to minister to the needs of the layman but up to this time its influence on the great interests of the people has been almost negligible.

A radical, and in every way salutary, change can be brought about in the Society's relations with the general public by the appointment of a committee to be known as the "Committee on Relations with the Public." The work of such a committee "would of course have to be done within carefully thought out and definitely prescribed limits. Even so, the work could be made very broad. The Committee would doubtless seek to establish such relations with the lay press as would make its advice and help sought when engineering matters are up for public discussion. It would also doubtless seek to give publicity to the fact that the Society stands ready to offer disinterested advice through its Council to government officials—municipal, state and national. In most cases, of course, this assistance would not be so much to answer engineering questions as to counsel with government officials as to the proper procedure to obtain answers."

A Committee on Relations with the Public might also provide for courses of lectures to the general public both at headquarters and under the auspices of local societies. Another important part of its work would be to see that a fair proportion of the professional papers presented to the various meetings of the Society should be of direct use and value to the public as well as to the mechanical engineer. It may seem difficult to see now how the work of the mechanical engineer can be made of direct interest to the public but it is reasonable to suppose that should the Society make cooperation with the public a definite part of its work lines of activity would be opened up which cannot now be foreseen. For the time being it would seem policy to interest the public in as much of the work of the engineer as can be made intelligible to them and to give to papers of general interest the widest possible publicity. The Freeman paper "On the Safeguarding of Life in Theatres" received comparatively little notice in the technical press and practically none in the lay press, yet it was of the highest public interest and importance and could have been made a potent influence in moulding public opinion had the Society had a proper organization for giving it the publicity it deserved.

"The matter of the conservation of our natural resources will afford probably for years a practically limitless field for investigation and earnest discussion. The questions involved are so momentous as to warrant the engineer in seeking ways of co-operating with the National and State governments for their solution. No better way could be found for our Society to assist in this work than to provide in its meetings and publications a forum for the discussion of those phases of the general problem in which the mechanical engineer is specially qualified to speak. Many of these questions must be made clear to the layman because legislation will be required for their proper solution.

"This further step in the line of cooperative engineering effort may seem to some of our members to be a radical one. But it appears to be only the logical sequence of those which have gone before. The records of engineering in the early days of the last century show that engineers had not then learned how to cooperate with each other. Up to a comparatively recent date the professional knowledge of an engineer was his own property and he felt that in imparting any of this knowledge to another engineer he was doing himself a decided injury. Discussions between engineers

were carried on mainly with the object of doing each other harm rather than good. The large number of engineering societies, with the fundamental object of the free exchange of engineering data between their members, show how thoroughly engineers have learned that the general policy of giving freely of their knowledge to their fellow practitioners increases rather than diminishes their effectiveness and, in proportion, their earning power. In proposing the appointment of this new standing committee, the writer suggests only the extension of this co-operation to include the public. There is good reason to believe that engineers have as much to gain from co-operation with the public as they have undoubtedly gained from co-operation with each other.

"If the Society once expresses a desire to receive papers of interest alike to the engineer and the layman, the time will probably soon arrive when the increasing number of such papers will suggest the necessity for a Section on Public Matters. Such a section would be conducted like any other section of the Society and would promote and receive papers on subjects of special interest to the layman. These papers and the discussion on them would naturally have to be handled in a way to make them not only intelligible but of practical value to the layman. This work would naturally give rise from time to time to broad practical summaries covering the essentials of good practice in fields where the general public is directly interested. These publications might easily become of the greatest value to legislators, national, state and municipal, on matters now generally settled without much professional advice or technical knowledge. Such a section would draw to its membership those members of the Society public spirited enough to be willing to devote some time to the investigation and discussion of technical matters in their application to the public interest. It would also probably attract as affiliates many of that rapidly increasing body of laymen who are giving freely of their time and money for the development of the best in the life of the whole people. The work of this section should be given a world-wide scope and interest. . . . . .

"As the range of human knowledge widens, the expense involved in carrying on the investigation and experimental work necessary to progress in such a profession as ours increases very rapidly. For the engineering profession to keep pace, for instance, with the progress being made today in medical science, our investigators and experimenters must have larger financial resources at their disposal than they have enjoyed in the past. Such foundations and bequests must come for the most part from those unconnected with the engineering profession and from those who put a value on the engineer's work for mankind. Such assistance will result only from a widespread appreciation of the engineer's achievements for the public good and of the requirements of engineering.

"It is no longer possible for either a profession or a craft to corner information and hold it for its own use. Broadly speaking, those who seek information in any field can obtain it, or at least enough to answer their immediate purposes. And therein lies a danger. This danger would in itself constitute a sufficient reason for the engineer to take the public into his confidence. For after all it is public opinion and not the dictum of the engineering fraternity which finally decides the large questions of engineering practice. How much better it would be then to join forces with the people, to work out with the people the people's problems and to build up in the lay mind such a confidence in our devotion to the people's cause that they will be willing to let us lead in matters where our training especially qualifies us to do so. Only by educating the public to understand and appreciate the work of the engineer, can the public be made to demand the best that can be devised and executed by trained and skillful men. This will have a two-fold beneficial effect on the profession in that it will make more work for the engineer and will give the public that general acquaintance with engineering matters which will make it suspicious of short-cuts. . . . . .

"There may be some who feel that in launching a movement of the kind proposed the Society would run the risk of getting into difficult positions and even of antagonizing friendly interests. Judging from what is going on around us in this Republic today, and in fact throughout the world, a step of this kind will commend itself so powerfully to the public as to bring to our standard a hundred friends for every one we could possibly lose. However, were this not so there is no sacrifice which the profession ought not to be glad to make to put itself in line with the most advanced ideas of public service. For after all the greatest value to come out of the broader activities is the inspiration to the individual engineer in his everyday work from this closer association with that great employer, the people, for whom in the last analysis all useful work is done."

PROGRESS ON THE PANAMA CANAL.

A SUMMARY OF PROGRESS DURING THE YEAR ENDING JUNE 30, 1908.

Annual Report of the Isthmian Canal Commission.

THE Annual Report of the Isthmian Canal Commission which was made public last month reviews the work done and the progress made during the fiscal year ending June 30, 1908. We are unable to give prominence in detail to the many interesting features of the Report but we summarize below the progress made along a few of the more important lines.

In the Culebra division, extending from the Chagres River in the vicinity of Gamboa to include the Pedro Miguel lock, a distance of 9.2 miles, the total amount of material excavated amounted to 12,065,138 cubic yards, place measurement, of which 11,685,253 cubic yards were from the canal and the balance for accessory works. The total number of steam shovels used during the year on this division was 59. Most of the material was hauled over the main line of the Panama Railroad an average distance of ten miles to dumps at Gorgona and Tabernilla on the north and to new dumps at Miraflores and La Boca on the south. Rock from the cut at Bas Obispo has been taken to Gatun, and since March 20, 1908, about 1,300 cubic yards daily have been deposited on the south toe of the dam between the lock site and the temporary spillway, forming part of the dam.

Considerable trouble was experienced on this division with earth slides. On Oct. 4, 1907, the Cucaracha slide started to move toward the east edge of the canal at a rate at first of 14 feet, and, toward the close of the month, of 4 feet, in 24 hours. About 113,000 cubic yards of material moved so as effectually to stop transportation of material through the cut to the south, and it was the end of the month before sufficient space was gained on the moving mass to permit the passage of dirt trains to the south over the old route. The total area of the slide was approximately 34,455 square yards and it was estimated that about 600,000 cubic yards were in motion. A slide at Paraiso gave trouble in April, 1908. The estimated area was 16,700 square yards and the amount of motion was about 140,000 cubic yards, of which about 90,000 were removed. Two smaller slides developed during the dry season at New Culebra and Las Cascadas.

In the Chagres division, covering a distance of about 23 miles and extending from Gatun to a point where the canal crosses the Chagres River at Gamboa, final surveys were completed and the centre line of the canal permanently marked. Slight changes in alignment were made in the final location whereby a saving of 1,264,700 cubic yards, 264,300 cubic yards rock, was effected. The total amount to be excavated in this section is 12,256,300 cubic yards, of which 8,313,500 cubic yards are earth. During the year the total amount excavated was 1,774,124 cubic yards, place measurement, all from the canal prism. The total number of steam shovels in operation was 15.

Dredging was done on the Colon dredging division by two French ladder dredges, two dipper dredges, the 16-inch suction dredge, and by the sea-going suction dredge *Ancon*. A total of 5,087,623 cubic yards of material was removed, of which 4,947,330 cubic yards were from the canal prism and the remainder from accessory works. The dry dock was enlarged to accommodate vessels 298 feet long, 50 feet beam, and 15 feet draught. On the La Boca dredging division the total amount of material to be removed is estimated at 29,212,700 cubic yards, of which at least 1,500,000 cubic yards are rock. A drill scow and a Lobnitz rock breaker have been purchased for breaking up the rock so that it can be handled by the dredges. During the year 5,273,369 cubic yards of material were removed by the sea-going suction dredge *Culebra* and four French ladder dredges.

The dimensions of the locks were increased during the fiscal year so that the width in the clear will be 110 feet, the usable length remaining as before 1,000 feet. At the site of the Gatun locks, borings were continued to ascertain the depths of the strata disclosed by previous borings and to determine whether suitable material extended far enough below the level on which the lock walls are to be built to carry their weight. The borings were carried 50 feet below this level. The strata encountered were argillaceous sandstone, a hard conglomerate, a soft sandstone, volcanic tufa and a dense argillaceous standstone. The borings also disclosed ground water under pressure in small quantities in some of the conglomerate and in the soft sandstone. There is no doubt that the materials will bear the greatest loads that will be transmitted to them by the lock walls if provision is made to prevent the underground flow of water through the softer materials on which part of the walls will rest. It is intended now to use curtain walls connected with the underlying impervious stratum of argillaceous sandstone. Nine shovels were used on the excavations for the locks during the year. The total amount removed from the site was 1,769,115 cubic yards, of which 190,013 cubic yards were placed on the south toe of the dam, 69,432 were used in making a fill for the construction plant on the west side of the lock, and the remainder was used for fills on the relocation of the Panama Railroad.

At the Gatun dam site, extensive investigations were carried on to determine the character and extent of the foundation materials, the amount of ground water, and the amount and character of the available material for constructing the dam. Test pits and wash borings revealed a geological formation similar to that at the lock site. The foundation materials are of ample strength and the small amount of ground water can be prevented from affecting the foundations by sheet steel piling. Suitable construction material can be obtained in sufficient quantities by dredging. Investigations on two experimental dams have shown that a stable and water-tight dam can be built of the materials available by hydraulic methods. The construction work during the year consisted in the removal of 918,920 cubic yards of material from the spillway.

In the motive power and machinery department at the close of the year 2,206 men were carried on the rolls, and the expenditures amounted to $5,645,622.18. Three shops, located at Gorgona, Empire and Paraiso, handle all work except electrical installations. At the Gorgona shops repairs are made to locomotives, unloaders, spreaders and wooden car equipment. Practically one-third of the output was manufactured material, gray-iron, semi-steel, and brass and bronze castings. Labor and material costs per pound were $0.0359 for gray-iron castings and $0,1951 for brass, including the cost of patterns. The Empire shops perform general repairs to steam shovels, steel car equipment, rock drills, and similar excavating machinery. The labor and material cost of shop repairs to steam shovels during the year amounted to $145,479 for the 17,467,161 cubic yards of material excavated, or $0.00833 per cubic yard. The cost of field repairs was $0.01509 per cubic yard.

During the year the total cost of municipal improvements in the Canal

Zone was, for water works and sewers, $2,358,840.44, and for roads, etc., $1,174,778.26. For the construction, improvement and repair of buildings the total expenditure was $3,086,138.01, the 505 new buildings costing $2,181,913.39. The total number of buildings now on hand is 3,313.

The value of the material and supplies received during the year amounted to $11,607,094.63, and that of the disbursed material to $11,685,158.33. Of the material issued, $182,894.56 cover old French material utilized or disposed of during the year, including scrap brass, copper, and cast iron used in the foundries at the Gorgona shops.

Though a net decrease was made in the skilled force during the year, the number of new employees was practically the same as in other years, indicating the shifting character of the force and showing that it is practically renewed every year. The number employed in the United States shows a large decrease and the number employed on the Isthmus a corresponding increase. The increase in the unskilled force amounted to 500 Europeans and 1,000 West Indians. The total imports of unskilled laborers amounted to 4,150 West Indians and 3,650 Europeans.

Thanks to the better sanitation and better food the death rate among the employees was reduced by more than one-half. With an average of 43,057 names on the pay roll the death rate per thousand was 18.32. Among the 12,058 whites it was 15.34, and among the 30,999 blacks, 19.48, per thousand.

Disbursements on the pay rolls of the commission amounted to $18,062,000, the average payment per month to employees on the gold roll being $125.80, and on the silver roll about $40 gold per month. The total appropriations for the canal work up to the present time have been $120,964,468.58, and expenditures up to the close of the fiscal year amounted to $84,572,998.55, leaving a balance of $36,391,470.03 available on July 1, 1908. Of the expenditures, $68,365,320.26 were for construction and engineering, $3,758,896.24 for civil government, and $8,008,614.50 for sanitation and hospitals.

AN ELECTRIC POWER PLANT OF NOTABLE FUEL ECONOMY.

NOTABLE RESULTS OF FUEL ECONOMY TESTS ON THE REDONDO PLANT OF THE PACIFIC LIGHT AND POWER COMPANY.

C. R. Weymouth—American Society of Mechanical Engineers.

THE Redondo Plant of the Pacific Light and Power Company, near Los Angeles, California, one of the most recent examples of steam-driven generating stations in the United States, possesses several features of unusual interest. It is one of the largest plants using California crude oil as fuel and a number of novel features, notably an automatic system of regulation, are embodied in the design of the oil-firing apparatus. The most radical departure from recent practice is the adoption of reciprocating engines as prime movers in lieu of steam turbines. The plant was built under unusual conditions. The design of the whole installation was entrusted to a firm of contracting engineers on a fixed-sum contract, under a guarantee of a definite complete-plant economy subject to penalty and bonus stipulations. The interest of the various features of contract and design is, however, transcended by that of the remarkable results of the various fuel economy tests which were communicated by Mr. C. R. Weymouth to the American Society of Mechanical Engineers at the recent annual meeting. The bare outline of Mr. Weymouth's very comprehensive paper which we are able to give will convey only a part of the significance of his table of results reproduced on the opposite page, but it will serve to indicate the notable economy obtained.

Briefly described, the plant consists of three main units of 5,000 kilowatts each, arranged in general on the panel system. Each plant unit is driven by one McIn-

TABLE SHOWING RESULTS OF VARIABLE AND UNIFORM LOAD TESTS ON ONE 5000-KILOWATT UNIT, ALSO VARIABLE LOAD TEST ON COMPLETE PLANT OF PACIFIC LIGHT AND POWER COMPANY, REDONDO, CAL.

	Variable load average of 15-day tests	2000-kw. load test (Approx.)	3000-kw. load test (Approx.)	4000-kw. load test (Approx.)	5000-kw. load test (Approx.)	Variable load complete plant test
Duration of test, hours	24	5	13	14	23	24
Period of warming boilers, hours	.....	5:20	5:0	4:50	7:25	5:55
Average steam pressure at engine throttles, lb. per sq. in.	180.03	183.	181.74	180.9	180.3	173.76
Average superheat at engine throttles, deg. F.	82.46	87.99	92.	96.05	92.78	95.15
Average temperature circulating water inlet, deg. F.	63.03	61.64	61.41	61.34	62.4	59.33
Average temperature circulating water outlet, deg. F.	79.15	78.09	70.37	79.02	81.09	82.12
Average vacuum in condenser (corresponding 30 in. bar.), in Hg.	28.334	28.426	28.343	28.214	27.976	27.784
Average temperature of feed water leaving heater, deg. F.	146.9	184.3	167.8	155.9	150.7	177.22
Kilowatt output (including lights), kw-hr.	71615.24	11225.577	47126.457	58745.125	116809.748	215262.438
Deduction for lights, kw-hr.	125.	26.042	78.125	79.917	117.792	.....
Net kilowatt output, deducting lights, kw-hr.	71490.24	11199.535	47048.332	58665.208	116781.956	.....
Fuel oil as fired (334 lb. to bbl.) bbl.	303.387	50.01	195.458	244.783	496.910	957.566
Heat units per pound oil as fired, B.t.u.	17840.	17038.8	17920.8	17965.8	17838.	17717.
Sulphur in oil (by weight), per ct.	2.34	2.17	2.43	2.39	2.49	2.60
Moisture in oil (by weight), per ct.	2.38	1.82	2.08	1.895	2.70	2.59
Silt in oil (by weight), per cent.	.14	.138	.14	.113	.10	.....
Fuel oil corrected as per contract, bbl.	282.746	47.219	183.307	230.764	460.884	883.115
Economy (oil corrected as per contract), kw-hr. per bbl.	252.842	237.298	256.664	254.252	253.382	243.758
Economy (oil corrected as per contract), B.t.u. per kw-hr.	24438.	26039.	24074.	24302.	24386.	25349.
Economy corrected only for heat units in oil, B.t.u. per kw-hr.	25288.	26742.	24857.	25027.	25347.	26320.
Number of boilers in service	5	3	5	5	6	15
Combined efficiency of engine and generator based on separate exciter, per cent	.....	90.2	92.5	94.1	94.75	.....

tosh and Seymour double horizontal and vertical, compound, condensing, automatic, gradiron-valve engines, size 34 and 70 by 56 inches, directly connected to an alternator. The rated speed is 100 revolutions per minute and the engines are designed to operate at 175 pounds maintained throttle pressure, with 100 degrees F. superheat at the throttle. Directly connected to each engine is one ATB-60-pole, 5,000 kilowatt, 100 revolutions per minute, 18,000 volt, 50 cycle, three-phase General Electric generator of the flywheel type. In each plant unit are six Babcock and Wilcox boilers, each with 6,042 square feet of heating surface and designed for a steam pressure of 200 pounds, arranged in three batteries of two each, one boiler in each unit being intended for reserve. The boilers are provided with Peabody patent fuel-oil burning furnaces having a depth of 10 feet from boiler front to face of bridge wall. For the firing of the boilers of the unit tested an automatic system of regulation was employed, which controls the supply of oil to the burners, the supply of steam for atomizing purposes, and the supply of air. The condensing, superheating and feed-water heating apparatus are of the most approved type.

The tests made included an official 15-day variable-load test on No. 2 plant unit; uniform load tests on No. 2 plant unit at approximately 2,000, 3,000, 4,000, and 5,000 kilowatts output; and a test of the complete plant at variable load similar to the official test. The results of the tests are shown in the table. In connection with the official variable load test, Mr. Weymouth describes in great detail the provisions of the contract governing the test, the compromise standards applied in correcting the results, the condition of the plant at the time of test, and the organization of the operating force. The uniform load tests were carried out under approximately the same conditions of operation as the official test and these are fully discussed. For

this information the reader must be referred to the original paper. We can only note that the guaranteed fuel economy, based on an average quality of Bakersfield crude oil of known furnace performance, was 170 kilowatt-hours per barrel of oil. The actual economy obtained, from 237 to 256 kilowatts per barrel, is striking evidence of the remarkable economy of the complete plant. With regard to the wisdom of using reciprocating engines instead of turbines, Mr. Weymouth says that the best turbine performance on the Pacific Coast based on oil fuel is considerably under that of the Redondo Plant.

OIL FUEL ON SHIPBOARD.

A DISCUSSION OF ITS ECONOMY AND OTHER ADVANTAGES PECULIAR TO MARINE WORK.

Andrew Laing—Cassier's Magazine.

ON another page of this issue some details are given of the notable economy obtained in a large oil-burning land steam plant. That oil fuel is no less adapted to marine work than to land applications, both on the score of economy and because of other advantages which are not apparent in stationary installations, is shown by Mr. Andrew Laing in an article in *Cassier's Magazine* for November, 1908, from which we take the following extracts.

"The question of the use of oil for boilers in ships is largely one of pounds, shillings and pence, excepting in warships. Strategical and tactical considerations must predominate in this as in all matters associated with the fighting ship. This embraces, of course, the weight factor, where the advantage is with oil, and to this reference will be made later. But an additional point favourable to the naval service is the facility with which oil can be dealt with. In recharging a ship with fuel the gain in time is enormous as contrasted with the refilling of coal bunkers. In getting coal from distant bunkers at the end of or during a running fight, much labour is required when all hands may be needed for serving the guns. Even then the speed of a ship may be checked through insufficient supply. At such times, too, there is always danger of fires being choked with clinker, whereas with oil no such serious disadvantage can arise. In small craft, such as destroyers, the saving in weight makes it possible to realize speeds far in advance of those possible with coal. Thus, 30-knot destroyers using coal for raising steam for reciprocating engines require 25 tons of coal for 4-hours' run at 6,000 indicated horse-power, equal to 120 nautical miles at full speed. The displacement was 335 tons, so that the consumption of coal per 100 ton-mile was 139 pounds. It is not necessary to enforce the great increase of power required for 34 knots in the later British destroyers, especially as the vessels are larger and more seaworthy, being of 890 tons displacement. These vessels steamed at a speed of more than 34 knots for 6 hours, or for 207 nautical miles for 68¼ tons of fuel. Notwithstanding the greater power, nearly three times that of the 30-knot boats, the oil consumption was only 83 pounds per 100 ton-mile. Part of the credit for this result is no doubt due to the higher efficiency of the Parsons steam turbine at high speeds, but without oil fuel this speed result could not be achieved. The gain is applicable in practically the same degree to large fighting ships.

"In the merchant service the main consideration is financial, which is concerned not only with the relative calorific value for a given expenditure, but with the less weight and easier stowage of oil fuel, and consequently greater passenger and cargo capacity within a ship of given dimensions, and the greater facility of handling and resultant reduction in staff. Experience goes to show that one ton of liquid fuel is of the same value as 1½ tons of average coal as a steam-raising agent. This ratio may be taken as well within the mark, as some authorities state that 1 ton of oil is equivalent to 1¾ tons of coal.

"The volume of 1 ton of oil runs out at about 38 cubic feet, whereas 44 cubic feet of bunker space must be allowed for each ton of coal. From the above data it will be seen that for any given vessel, if oil fuel is adopted, the capacity of the bunkers can be reduced nearly 45 per cent., as compared with what they would require to be if burning coal; since not only is the weight of fuel to be carried reduced by 33 per cent., but also the oil fuel compared with coal requires per ton a very much reduced cubic capacity. The capacity thus saved is available for cargo space, or for the reduction in size and displacement, and therefore in power for a given speed.

"A very considerable saving is effected by the reduction of the number of firemen required, and also in the rapidity of loading liquid fuel as compared with the time required for bunkering coal. Space for crew accommodation is reduced.

"Where occasion arises for a sudden alteration in the load or power, oil fuel is much more suitable than coal, as considerably less time is occupied in adjusting consumption to suit the variation in the rate of evaporation required from the boilers.

"The burners can be so adjusted under all normal conditions that the installation shall be practically smokeless, and they should be so adjusted that the slightest possible trace of smoke is apparent at the chimney. This is preferable to the adoption of an absolutely smokeless installation, where an excess of air may be admitted to the furnace without means of detection, a condition which precludes the obtaining of the maximum of economy.

"It has been found in practice that where marine installations have been converted from coal to oil burning, there has been a marked improvement in the ability to secure and maintain a higher speed than was the case with coal.

"The oil is forced into the furnace in the shape of a conical spray of exceedingly fine particles, which burst into flame at a distance of 6 to 8 inches from the nozzle. The flame being conical, and there being no fire-bars fitted in the furnace, the whole circumference of the furnace is available for heating surface. This is a great advantage in the ordinary multitubular boiler, as the lower portion of the boiler becomes heated sooner than would be the case with coal, and consequently the circulation of water in the boiler is improved. Moreover, as the lower portion of the boiler is heated up uniformly with the upper portions, and as there is no inrush of cold air, since the furnace doors are never opened, there is practically none of that straining action which results from unequal expansion and contraction, due to rapid changes consequent on the opening of the door in coal stoking.

"From the point of view of upkeep, a considerable economy is obtained. The repairs to the bunkers, a very considerable item in coal-burning ships of any age, is entirely obviated, as the liquid fuel is a preservative of steel. These advantages can be worked out on a monetary basis; but the conditions vary in each trade, and it is, therefore, difficult to make a precise comparison. From data carefully taken from practical working on sea voyages, it is seen that in burning coal the cost per ton runs out at about 2s. for natural draught to 2s. 6d. for forced draught, including wages, victualling, repairs to furnace tools, stokehold plates, lamps, etc., but excluding the cost of the fuel, this being a separate item.

"If oil fuel be adopted, the cost of burning per ton of oil would be about 9d. for natural draught to 7½d. for forced draught for moderate-sized cargo steamers, and as low as 4d. per ton in large liners. It must be borne in mind that not only is the cost per ton for burning greatly reduced, but the amount burned is also less in the proportion of 1 of oil to 1½ or 1¾ of coal."

Mr. Laing gives a short review of the development of oil-burning apparatus for marine work and discusses at some length the Körting system. He draws particular attention to the economy of pre-heating the oil before its introduction into the boiler furnace. "Experience has shown that when the oil is heated before it is sprayed into the fur-

nace, more economical results are obtained. In the Körting system a heater of the tubular type is fitted between the oil-fuel pumps and the burners, and in it the oil is heated to the required temperature for giving the most economical results. The temperature is largely dependent upon the rate of combustion aimed at. During experiments under natural-draught conditions 15 pounds of water were evaporated from and at 212 degrees F. when burning about 280 pounds of oil in one burner in a furnace which would be reckoned as having a 20-square-foot grate. The temperature in this case was 212 degrees F., and the pressure of oil at the nozzle 60 pounds per square inch. With best Mickley picked coal the evaporation per pound of coal in the same boiler was 9.31 pounds, so that in this instance, on comparative trials under natural draught, 1 pound of oil was equal to 1.61 pounds of the coal named.

"With a closed stokehold on the same boiler nearly the same rate of evaporation per pound of fuel (14.06 pounds) was got under 1⅛-inch pressure on the water gauge, and the rate of oil fuel combustion was increased to 610 pounds of oil per burner, larger nozzles being used. To attain this result the pressure of oil at the nozzle had to be increased to 140 pounds per square inch, but as the disintegration of the liquid fuel increases with greater pressures, a lower temperature (110 degrees F.) was possible. Thus the rate of combustion can be enormously increased (in the cases quoted it was considerably more than doubled), while the rate of evaporation only fell off slightly. This is a great advantage for high-speed vessels. Nor was the economy in oil spray greatly affected, as the steam saved by the reduction in temperature partly compensated for that required for the increased pressure. . . . . .

"Indeed, there is no unsurmountable obstacle from the mechanical point of view to the universal application of oil fuel for steam raising under all conditions. Even if the price of oil were much greater than coal there might be financial gain in ship propulsion, in view of the direct and indirect economies realizable, as already enumerated. The advisability of fitting our large Atlantic liners with oil-burning installations has been considered. This is quite feasible, but in this, as in so many cases, the question is one of economics, and concerns the certainty of obtaining the oil conveniently in sufficient bulk and at a price which would establish a financial superiority to coal."

THE COMPARATIVE EFFICIENCY OF MARINE ENGINES AND TURBINES.

A COMPARISON BASED ON THE PERFORMANCES OF THE "KAISER WILHELM II" AND THE "LUSITANIA."

R. Caird—Cassier's Magazine.

PREVIOUS to the building of the *Lusitania*, the *Kaiser Wilhelm II* held the blue ribbon of the Atlantic with a speed of 23.73 knots. Her length was 706.5 feet and her displacement 26,000 tons. The indicated power of her engines was 20,000 horse power. The *Lusitania* with a length of 785 feet and a displacement of 38,000 tons, driven by turbines developing 65,500 shaft horse power, has easily attained the speed of 25 knots for which she was designed, but, in the opinion of many, at much lower efficiency than the older and slower vessel driven by reciprocating engines. In an article in *Cassier's Magazine* for November, 1908, Mr. R. Caird discusses the relative efficiency of piston engines and turbines with reference to these two vessels, from which we take the following extracts. His data on the *Lusitania* are taken from the paper read by Mr. Thos. Bell before the Institution of Naval Architects and abstracted in these columns in our issue for June, 1908.

"It is noteworthy that in fixing the dimensions of the *Kaiser Wilhelm II* and of the *Lusitania* the naval architects

have been careful to select the most suitable lengths and coefficients of fineness, having regard to the maximum designed speed. Hence, in comparing performances it is safe to assume that both vessels are, as regards size and form, respectively, as suitable as, in the present state of our knowledge it is possible to design them. . . . .

"There are several methods of comparison of the performances of steamers. One very commonly used is that afforded by what is known as the Admiralty or $D^{\frac{2}{3}}$ coefficient, which assumes that the coefficient varies directly as the product of the $\frac{2}{3}$ power of the displacement and the cube of the speed, and inversely as the indicated horse power. Applying this to the German steamer and to the Cunarder at maximum speeds, the relative coefficients work out at 293 and 257. That is to say, on this criterion the piston engine is 14 per cent. more efficient than the turbine. For strict comparison an allowance should be made in favour of the German steamer, the coefficient being *ipso facto* higher for greater displacement. In this calculation the shaft horse power, as given in Mr. Bell's paper, has been taken as 97 per cent. of the indicated horse power. It is difficult to determine exactly what the percentage should be, but there is not much range for error in the above if we consider that the German tests of the ratio of shaft horse power to indicated in reciprocating engines was less than 94 per cent.—exactly 93 per cent. by torsion meter tests in the case of the *Kaiser Wilhelm II.*

"The low propulsive efficiency of the *Lusitania* as given in Mr. Bell's paper, and the exceptionally low rate of coal consumption, point to either inaccuracies in the torsion meter readings or to a very high engine efficiency or to both. But the coefficients given above would not be materially affected even if the initial and working friction of these turbine engines were taken as nil, provided that a proper correction were made for greater displacement. The steam efficiency of the *Lusitania* is so high that the reason for the low general efficiency found from the $D^{\frac{2}{3}}$ coefficient must be sought for elsewhere. It seems that it must be looked for in the application of the power through the propellers, whether in the propeller efficiency or in the thrust deduction due to the position of the propellers it is impossible to say without full information. It must be borne in mind that the *Kaiser Wilhelm* has two screws and the *Lusitania* four, and the wing propellers being less immersed than the centre ones, have less hydraulic head and are probably less efficient. Be that as it may, the fact remains that the *Lusitania* is about 14 per cent. less efficient than the *Kaiser Wilhelm* on the Admiralty coefficient test.

"There is another test which may be applied, that of the coal consumed for every 1,000 tons displacement per 1,000 nautical miles run per knot speed. The *Lusitania* takes 1.93 tons and the *Kaiser* 1.7 tons, the former being 13.5 per cent. less efficient when tested by this formula. This agrees very closely with the figure got by the Admiralty constant, and, as in that case, some further credit is due to the German steamer in respect of the *Lusitania's* greater displacement. Speaking generally, the *Kaiser* is about 15 per cent. more efficient than the *Lusitania*.

"What are the benefits to set off against this loss? Of course the appeal to the imagination of the public has an advertising value. It is questionable, however, if this will be lasting, or even if it has proved to be of much value. It is claimed for turbines that an almost entire absence of vibration may be counted upon; but experience does not bear this out, and it is difficult to see how the effect of the couples set up by varying thrusts in a horizontal plane exerted through the shafts can be obviated.

"Another advantage claimed for turbine engines is the reduction of weight of machinery; and the claim must be conceded, chiefly on account of the reduction of boiler weight, due to decreased pressure in the case of the turbine. It does not seem, however, that in large installations much reduction in weight has been effected: and even if it had been, the greater amount of coal to be carried, due to the lower efficiency, would more than offset the gain.

"It may be interesting to consider for a moment what economies might be effected in a *Lusitania* fitted with piston engines. It is somewhat difficult to put the necessary calculations sufficiently clear for general comprehension within the space available in any other than tabular form, but a comment running through the figures may prove useful. Taking the mean displacement at 37,080 tons, draught 32 feet 9 inches, the effective horse-power from Mr. Bell's diagram is 31,700. For prudence, taking the resistance due to the bosses with three propellers as 5 per cent. more than with four, the shafts being of greater diameter, and assuming a hull efficiency of 90 per cent., the thrust horse-power works out at 36,983.

"With three propellers of 25 feet diameter, having 200 square feet surface on three blades, or a surface ratio of 40.7 per cent. and 80 revolutions per minute, set at a pitch of 35 feet, the apparent slip is 9.5 per cent., and the propeller efficiency by Froude's latest curves nearly 74 per cent.

"Assuming an engine efficiency of 90 per cent. and a propeller efficiency of 70 per cent. the indicated horse-power at 25 knots is 58,700; the Admiralty coefficient 296, and the propulsive coefficient 54 per cent. These efficiencies are all taken lower than those deduced from the best practice. The horse-power passed through each shaft is less than that in the *Kaiser Wilhelm der II.*

"Three sets of quadruple expansion engines of the following dimensions would be sufficient to develop the required power: Cylinders 51 inches, 73 inches and 103 inches; two of 103-inch; stroke 6 feet. Boiler pressure 215 pounds.

"The coal consumption at 1.35 pounds per indicated horse power per hour would be 850 tons per day, or 250 less than that of the big Cunarders—a saving sufficient to drive the C. P. R. *Empress of Britain* at 19½ knots.

"Two of the Cunarder's double-ended boilers could be dispensed with. The following table shows approximately the actual and estimated trial results in the turbine and piston-engine cases respectively:

	Lusitania.	Proposed.
Speed, knots	25	25
Revolutions	186	80
Slip, per cent	15.5	9.5
Shaft horse-power	65,500	52,830
Propulsion efficiency on shaft horse-power, per cent	48.4	60

THE BONUS SYSTEM OF WAGES.

A DISCUSSION OF ITS VALUE IN TRAINING WORKMEN IN HABITS OF INDUSTRY AND CO-OPERATION.

H. L. Gantt—American Society of Mechanical Engineers.

MR. BENDER, in his comparative review of systems of wages and their influence on efficiency in THE ENGINEERING MAGAZINE for December, 1908, emphasized the fact that psychology is quite as important a factor in the success of wage systems as any other condition. Commenting on the Gantt bonus system, he expressed a belief that it shows certain psychological disadvantages in practice, chief among them being an understanding among the men not to do better than standard times. Mr. H. L. Gantt, the originator of the system, however, holds no such view. In a paper read at the recent annual meeting of the American Society of Mechanical Engineers he gives the results of several years' experience with the system, which he considers the most effective plan yet developed for training workmen in habits of industry and co-operation. We give below a brief abstract of his paper.

"The widespread interest in the training of workmen which has been so marked for several years is due to the evident need for better methods of training than those now generally in vogue. The one point in which these methods as a class seem to be lacking is that they do not lay enough stress on the fact that workmen must have industry as well as knowledge and skill. Habits of industry are far more valuable than any kind of knowledge and skill, for with such habits as a basis, the problem of acquiring knowledge and skill

is much simplified. Without industry knowledge and skill are of little value, and sometimes a great detriment. If workmen are systematically trained in habits of industry, it has been found possible, not only to train many of them to be efficient in whatever capacity they are needed, but to develop an effective system of co-operation between workmen and foremen."

Men are most successfully trained in these habits under the bonus system of rewarding labor. "Under this system each man has his work assigned to him in the form of a task to be done by a prescribed method with definite appliances and to be completed within a certain time. The task is based on a detailed investigation by a trained expert of the best method of doing the work; and the task setter, or his assistant, acts as an instructor to teach the workmen to do the work in the manner and time specified. If the work is done within the time allowed by the expert, and is up to the standard for quality, the workman receives extra compensation (usually 20 to 50 per cent. of the time allowed) in addition to his day's pay. If it is not done in the time set, or is not up to the standard for quality, the workman receives his day's pay only."

As Mr. F. W. Taylor has repeatedly emphasized, tasks should be set only as the result of a scientific investigation. The scientific investigation of a process which has grown up without the assistance of science has an educational value which can hardly be over-estimated; it always reveals possibilities of improvement in methods and of reduction in costs. The results of investigations, however, are of little practical value unless workmen can be taught how to use them and then can be induced to do as they are taught.

For this purpose an instructor, a task and a bonus have been found most useful. While workmen prefer to work at the speed to which they have been accustomed, they are usually willing to work at any reasonable speed and in any reasonable manner if a suitable inducement is offered and they are so trained as to be able to earn the reward. The bonus system is of course most effective when the men are already skilled, but with the bonus as an incentive and with a proper instructor a large proportion of the unskilled are brought to a high degree of efficiency and succeed in performing a task which was at first entirely beyond them. Once skilled in a certain line of work, they readily learn others; they form better habits of work, lose less time and become more reliable.

The formation of proper habits of work is one of the most important results of the task and bonus system. In all work both quantity and quality must be considered. The task method demands a maximum quantity, all of which must be up to the standard for quality. Workmen trained under the system acquire the habit of doing a large amount of work well; in fact, the quickest workers almost always do the best work when following instructions. In a workman ability and willingness to do are at least as important as knowing how. Under the bonus system the workman is taught how and trained to do efficiently at the same time, and the habit of doing efficiently what is laid out for him becomes so fixed that he performs without hesitation tasks at which a man not trained to follow instructions would absolutely fail. Learning to obey orders is often the hardest part of the workman's task, but once he has acquired the habit he learns that the skilled investigator can learn more about doing a piece of work than he knows "off hand" and in the endeavor to earn his bonus he soon becomes, if he has the natural ability, a rapid and skillful workman.

In a shop operated on this system, where each workman has his task, the gang boss of each group of workmen, who supplies them with work and appliances and removes the work when finished, is paid a bonus depending on the amount of bonus earned by the men under his charge. He thus has an incentive for giving the workmen all the help he can and for keeping their efficiency up to the highest possible point.

In starting a shop on task work, an instructor capable of teaching a work-

man how to perform his task must be constantly on hand. Instruction as a rule is given individually. The instructor may be the man who investigated the work and set the task or he may simply be capable of following out the work of the investigator. After the workman has done the task in the manner and time specified he is given an opportunity of suggesting a better or quicker method. Unless an investigator is able to develop methods a great deal better than those suggested by the workmen he is not retained in his position. Working at tasks is good training for setting them and a number of workmen in Mr. Gantt's employ have risen to the rank of task setter.

After a satisfactory method has been established, a large proportion of the work of the task setter is the study of the time in which operations can be performed and he is popularly known as the "time study" man. This term has led to a misconception of his duties. Many managers have thought it sufficient for the introduction of the bonus system to determine by stop watch how quickly their best men were doing certain work. They have in many cases been able to establish more accurate piece rates by this method, but they are still far from the ideal of the bonus system in which the best expert available investigates the work, standardizes the appliances and methods and sets a task that involves using them to their very best efficiency. Stop-watch observations on work done inefficiently or with ill-adapted machines or by poor methods is absurd.

To make real and permanent progress, the expert must be able to standardize appliances and methods and write up such instructions as will enable an intelligent workman to follow them. Such standards become permanent and if the workman is paid a proper bonus for doing the work in the manner and time set, he not only helps to maintain the standards, but soon begins to exert his influence to help the progress of standardization. With increasing efficiency of the workmen the standards always have a tendency to become higher.

The principal difficulty in the introduction of the system is that it forces every man connected with the organization to do his duty. When carried out properly it is no respecter of persons. The man who wishes to force the workman to do his task properly must see that the task is properly set and that proper means are available for doing it. The workmen have the right to report whatever interferes with the earning of a bonus and the man responsible for unfavorable conditions has to see that they are remedied or make way for someone else. The main opposition to the introduction of the system develops on the part of those who are not sure of making good under it. The principal help comes from the workmen themselves. They soon learn that the system is to their advantage and the sentiment grows rapidly in favor of task work.

The system is really a combination of the best features of the day-rate and piece-work systems. While learning to do his task the workman is on a day rate; when he has learned to do it the compensation for the task is a fixed quantity, really equivalent to piece rate. The method of payment then is day rate for the unskilled and piece work for the skilled. The system has none of the disadvantages of either system, for the day worker who has no ambition to become a bonus worker usually seeks work elsewhere of his own free will and the working force soon becomes composed of bonus workers and day workers who are trying to become bonus workers.

When 25 per cent of the workers are bonus workers, they, with the day workers who are trying to reach the bonus class, control the sentiment and a strong spirit of co-operation develops. This benefits the employer by increasing production, improving quality and lowering costs. It benefits the worker by giving him better wages, increased skill and better habits of work. The development of skilled workmen by this method is sure and rapid, and its proper establishment solves the problem of securing satisfactory help.

"The fact that under this system everybody, high and low, is forced by

his co-workers to do his duty, for someone else always suffers when he fails, acts as a strong moral tone to the community, and many whose ideas of truth and honesty are vague find habits of truth and honesty forced upon them. This is the case with those in high authority as well as those in humble positions, and the man highest in authority finds that he also must conform to laws, if he wishes the proper co-operation of those under him."

THE APPLICATION OF MOTORS TO MACHINE TOOLS.

A DISCUSSION OF THE MOTORS SUITED TO VARIOUS CLASSES OF WORK AND METHODS OF SPEED CONTROL.

Dexter S. Kimball—The Mechanical Engineer.

THE economy of the individual motor drive for machine tools, as opposed to the group system, was exhaustively discussed by Mr. Howard S. Knowlton in THE ENGINEERING MAGAZINE for December, 1908. In *The Mechanical Engineer* for November 27, 1908, Mr. Dexter S. Kimball makes a similar argument for the individual drive and, in addition, discusses at length the types of motors adapted to various classes of work and the principal methods of speed control. With the first part of Mr. Kimball's paper we shall not deal: his conclusions are in the main those of Mr. Knowlton; but we present below an abstract of the concluding section, dealing with the choice of motors and the methods of connecting them to the machines.

"Machine tools may for this purpose be classified into the following groups: (*a*) machines requiring a constant speed, in which the torque may vary with the demand for power; (*b*) variable-speed machines requiring maximum power at minimum speed; in this class are most machine tools where automatic regulation is needed; here the cutting speeds are practically constant for a given material, but the cuts are larger on the larger work; (*c*) variable-speed tools requiring heavy starting torque, as cranes, etc., where regulation of speed is by hand; (*d*) machines requiring a torque increasing with the speed, as blowers and fans which give variable blast, a rather unimportant class."

There is no trouble in meeting the requirements of the constant-speed machines but the problem of variable speed has received no entirely satisfactory solution. No mechanical speed-changing device has yet been produced that will answer the purpose. Many have been devised that will give any speed within the limits of the mechanism, but they all depend on friction and are very large and cumbersome. The devices which are positive in their action give only several speeds between the limits and are therefore not entirely satisfactory, though a number of those now on the market can be used with success in many places.

On the electrical side two distinct systems of distribution are offered, the alternating- and direct-current systems. In general it may be said that when the alternating-current system can be used it is preferable, as the wiring is smaller on a large system and the generators and motors are simpler and more reliable. It has, however, limitations to its application to the driving of machine tools.

The alternating-current system offers two kinds of motors, the synchronous and the induction motor. The former is not self-starting and, except in a few cases, as for instance when used in connection with induction motors for steadying the line and helping the power factor where heavy shafts are to be run for some length of time, it has no place in machine-tool driving. In small sizes it is not at all suitable. The induction motor is self starting and, like the synchronous motor, tends to run at constant speed. Though by nature not a variable speed machine, it can be made so in several ways, none of which, however, has so far proved adequate to the demands of machine-tool driving. Speed

variation can be obtained by putting resistance in the secondary. Induction motors controlled in this manner are successfully used on cranes and similar devices. Fairly successful speed variation has been obtained in at least one plant using induction motors by varying the frequency, but as yet the induction motor cannot be considered as the equal of the direct-current motor for variable speed work. If a plant contains constant-speed machines principally, however, the induction motor in connection with a mechanical speed-changing device will generally prove to be the best, and where all the machinery is of the constant-speed type it is much preferable.

The direct-current system offers three kinds of motors, the combined characteristics of which cover much more closely the requirements of the case than do those of the alternating-current motor. These are the series-wound, compound-wound, and shunt-wound motors.

"The series motor is a variable-speed motor with great starting torque. It can be controlled throughout its whole range of speed, and would seem at first glance to be almost ideal for lathes and boring mills. It is, however, very uneconomical, as the control is obtained by resistance in its circuit. It also requires an expensive controller on account of the heavy current to be handled, and must be controlled by hand, as its speed varies inversely with the load, and under light loads it will run away. It is an excellent motor for cranes, elevators, etc., and occupies a very important place in the equipment. It therefore covers the requirements of the tools in class (*c*).

"The compound-wound motor is suitable where small variations of speed are needed, coupled with a large starting torque. It will, of course, give constant speed when set for any set of conditions within its range.

"The shunt motor is, in its standard form, a constant-speed motor. When set to run at a given speed it will not vary appreciably under varying load up to its capacity. It can be made to vary its speed in a number of ways, those which are most used being as follows: by varying the current in the armature; by varying the strength of the field; by varying the voltage applied to the armature terminal. These characteristics make the shunt-wound motor most suitable of any for the purposes of machine-tool driving, and by means of these methods of control, either singly or in combination with each other or in combination with gearing, most of such work is now accomplished.

"A discussion of the principal methods of speed control may be of interest. If the armature current in a shunt-wound motor be decreased by inserting resistance, the field remaining constant, the speed of the motor will decrease. But when this method of control is used the motor loses one of its most valuable qualities. It will no longer run at constant speed under varying load. Besides, this method of control, like that of the series-wound motor, is very wasteful, and the controller must likewise be large and complicated to handle the large current which must be broken. This method, therefore, has ceased to be used to any great extent.

"If the field strength of the shunt motor is varied the speed will vary accordingly, and in this method of control the bad features of the above method do not appear. The field current is small, and therefore the resistance loss small and the controller simple and cheap. The motor, likewise, retains its good quality of steady running. The power, however, falls off, for now the commutating ability of the field has decreased, so that less current can be passed through the armature. In order, therefore, to get a given output at higher speed with field control the motor must be larger than one built for the same output at the normal fixed speed, and to get a large range in this manner the motor must be very large. It will be noticed, however, that the characteristic of the motor fits the requirements of tools in class (*b*), and it is therefore much used for driving this class.

"If the field strength is kept constant and the impressed volts at the armature terminals be varied, the speed of the shunt-wound motor will vary accordingly. Theoretically, this is a most excel-

lent method of speed control, as it allows the use of a smaller motor than in the method of field control, and the efficiency of the motor at the various voltages is high. In practice, however, the number of voltages that can be supplied is limited, and therefore in its simplest form the system has the same defect as the method of controlling alternating induction motors by changing the frequency. It is usual, therefore, to make the motors large enough to have field control sufficient to reach between voltages, which makes a system that completely covers the range between voltages and extends the range beyond the speed normal at highest voltage."

Mr. Kimball shows by practical examples how this method may be applied on 4- and 3-wire systems. Of the former case he says: "Undoubtedly this system works well, but like all the others it has its defects. It is not desirable to carry high voltage round manufacturing plants, for obvious reasons, so that in order to get a large range in this manner the lowest voltage must be very low. To obtain the full output at low speed—and it has been seen that generally the greatest output is required at the lowest speed—the current must be increased; so that the expense of wire runs up rapidly for wiring the low voltages, or if the mains are kept down in size, the line losses are heavy, and the impressed volts drop off, the motor slowing down accordingly. Further, the obtaining of only six voltages by a 4-wire system introduces considerable complication, as is easily seen, besides the extra expense for controllers, wiring, and the machines for giving the various voltages. Generally a motor-generator set of some form is run from the main series of the principal generating set which splits the voltage of these mains. Thus a 250-volt circuit can be divided by two wires from such a set into 60, 80, and 110 volt steps, and the combinations of these give six voltages.

"If it is not desired to use the excessively large motor resulting from entire field control or the complication of multi-voltage, a combination of field control and gearing can be used. This method, which is a compromise between the other systems, has many good points. The wiring and generating systems are simple, as only a single voltage is necessary, and the motor need not be excessively large for the work, as it can be worked at the maximum range of speed which is allowable for gear connection. The voltage is always the highest permissible, hence the wiring is small; and while the multi-voltage system gives somewhat quicker change of speed, the difference in well-designed machines will not be very great. In the writer's opinion it is a logical system, and will be very widely used in machine-tool work, mainly on account of its electrical simplicity. The efficiency of such a system is good, and if the gearing is properly designed the range covered by the motor alone need not be great enough to make it large and clumsy."

Mr. Kimball gives a table showing the relative sizes of motors which must be used with the 4 to 1 field control, 4-wire multi-voltage, 3-wire multi-voltage, and 2 to 1 field control with 2 to 1 gearing systems, to cover the range from 400 to 1,600 revolutions per minute and with a maximum voltage of 240. He concludes:

"It is easily seen that the range of any of the above systems of speed control is somewhat limited, the 4-wire multi-voltage having the widest for the same size of motor. But even this is limited as here laid down to about 6 to 1 when using field control on the highest voltage. It is true that it can be extended by using either higher or lower voltages, both of which are undesirable. Now machine tools which require variable speed may have a range of as high as 50 to 1. While, no doubt, many tools are furnished with a greater range than absolutely necessary, 6 or 8 to 1 being found sufficient for many purposes, at present none of the systems outlined will conveniently cover such ranges. Resort must therefore be made in most cases to gearing to finish out the range even with multi-voltage. When the range to be covered is very great this last system has an advantage, but for most machines the range required can be covered with a field control of 2 to 1 and two sets of gears, and for the larger

ranges which are not so frequent, a field control of 3 to 1 can be used.

"Where a 3-wire system is already installed the application of variable speed drives is easily accomplished by the system outlined. But when the case of a new plant is under discussion, careful consideration should be given to the foregoing principles, and the system should depend largely on the ratio of variable-speed tools to constant speed tools. If the plant is large enough, an alternating system with proper transforming devices might prove the best, and in the writer's opinion many large plants now equipped with direct-current distribution would be much more economically run if so provided."

THE ELECTRIC STEEL FURNACE.

A SUMMARY OF THE INSTALLATIONS OF THE ELECTRIC FURNACE FOR STEEL PRODUCTION NOW IN USE OR UNDER CONSTRUCTION IN ALL PARTS OF THE WORLD.

Stahl und Eisen.

A TABLE published in *Stahl und Eisen* for October 7, 1908, and reproduced in full below, gives what is believed to be a complete summary of the electric furnaces for steel production now in use or under construction in all parts of the world. It is abundantly evident from the size and wide distribution of the installations that the electric furnace for this class of work has emerged from the experimental stage and has won for itself an important place in the metallurgy of iron and steel. The table is divided into two parts, covering, respectively, furnaces of the induction and arc types. Of the former the total number in use or under construction is 35, and of the latter, 43.

TABLE OF ELECTRIC STEEL FURNACE INSTALLATIONS NOW IN USE OR UNDER CONSTRUCTION IN ALL PARTS OF THE WORLD.

I. INDUCTION FURNACES.

a. KJELLIN.

Firm.	Capacity, Kilogrammes.	Power Requirements, Kilowatts.	Current.	Remarks.
1. Röchlingsche Eisen- und Stahlwerke, Völklingen	8,500*	750	Single phase	.....
2. Fried. Krupp A.-G., Essen	8,500	750	" "	.....
3. Oberschlesische Eisenindustrie-A. G., Gleiwitz, Germany	1,500	180	" "	.....
4. Poldihütte, Kladno, Bohemia.....	4,000	440	" "	.....
5. J. Brauns' Söhne, Vöcklabruck, Austria.....	400	65	" "	.....
6. Allg. Kalziumkarbid-Genossenschaft, Gurtnellen, Switzerland	....*	330	" "	.....
7. Vidua de Urigoitia è Hijà, Araya, Spain.....	1,500	215	" "	.....
8. Alti Forni Gregorini, Lovere, Italy.....	1,500†	330	" "	.....
9. Eisenwerk Domnarfvet, Gysinge, Sweden.....	1,500	175	" "	.....
10. Metallurgiska Aktiebolaget, Trollhättan, Sweden	2,000†	300	" "	.....
11. Vickers, Sons & Maxim, Sheffield, England.....	550	150	" "	.....
12. Gröndal-Kjellin Co., London, England.....	100	60	" "	Experimental furnace.
13. American Electric Furnace Co., Niagara Falls..	800	150	" "	.....
14. " " " " " " ..	100	60	" "	.....

b. RÖCHLING-RODENHAUSER.

1. Röchlingsche Eisen- und Stahlwerke, Völklingen	3,500	400	Single phase	Charge taken from Bessemer converter.
2. " " " " " "	8,500†	750	" "	
3. " " " " " "	2,000	275	Three phase	
4. Bergische Stahlindustrie, Remscheid, Germany.	5,000†	500	Single phase	.....
5. Le Gallais, Metz & Co., Dommeldingen, Germany	700	100	" "	Charge, molten pig iron; later will use molten steel from the large furnaces.
6. " " " " " "	3,500†	300	" "	Charge, molten pig iron.
7. " " " " " "	3,500†	300	" "	
8. " " " " " "	1,500†	275	Three phase	Charge, molten steel from the large furnaces.
9. Aciéries Liègoises, Bressoux-les-Liège, Belgium	1,000†	200	" "	For steel castings. Charged cold.
10. J. Knöpfel, Walzenhausen, Switzerland.....	1,000†	175	" "	" " " "

Firm.	Capacity Kilogrammes.	Power Requirements, Kilowatts	Current.	Remarks.
c. SCHNEIDER.				
1. Schneider & Co., Creusot, France	1,000	...	.....	Experimental furnace.
d. SCHNEIDER-GIN.				
1. ——— Plettenberg, Germany	4,500†	400	Single phase	.....
e. COLBY.				
1. H. Disston & Sons, Philadelphia, U. S. A.	90	...	Single phase	Current, 240 volts, 50 periods.
f. FRICK.				
1. Fried. Krupp A.-G., Essen	10,000	750	.....	.....
2. John Brown & Co., Sheffield, England	1,800	200	.....	.....
3. Wm. Jessop & Sons, Sheffield, England	3,000*	450	.....	.....
g. WALLIN.				
No longer used.				
h. HIORTH.				
No longer used.				
i. A.-G. ELECTROMETALL, LUDVIKA, SWEDEN.				
1. ——— Arkiva, Sweden	1,000	175	Three phase	
2. ——— Hagfors, Sweden	500†	125	" "	For steel production.
3. St. John del Rey Mining Co., Brasil	2,000†	300	" "	" "

A 450-kilowatt three-phase furnace of this type is used at the Eisenwerk Domnarfvet, Gysinge, Sweden, for the production of pig iron. It has a capacity of 2,000 tons per year.

2. ARC FURNACES.

a. HEROULT.

1. Stahlwerke Richard Lindenberg A.-G., Remscheid-Hasten	3,000	370	Single phase	Produces tool steel. Charged with molten steel from the open-hearth furnace.
2. Stahlwerke Richard Lindenberg A.-G., Remscheid-Hasten	1,800	300	" "	" " "
3. Bismarckhütte, Bismarckhütte, Germany	3,000	400	" "	Produces tool steel. Charged molten or cold.
4. " " "	1,000	260	" "	" "
5. Deutsch-Oesterreichische Mannesmannröhren-Werke, Burbach	3,000†	400	" "	Charged with molten open-hearth steel. Product used for seamless tubes and steel castings.
6. Danner & Co., Judenburg, Austria	2,000	300	" "	Produces tool steel. Charged from the open-hearth furnace.
7. Gebrüder Böhler & Cie., A.-G., Kapfenberg, Austria	2,500	350	" "	" "
8. Gebrüder Böhler & Cie., A.-G., Kapfenberg, Austria	....†	...	" "	.....
9. Georg Fischer, Schaffhausen, Switzerland	1,000	250	" "	Charged cold. Product for steel castings.
10. " " " " "	5,000†	...	" "	
11. " " " " "	5,000†	...	" "	
12. Société Electrométallurgique Française, La Praz, France	3,000	370	" "	Charged cold.
13. Aciéries du Saut du Tarn, St. Juery, France	5,000	600	" "	" "
14. Aktiebolaget Héroults Elektriska Stal, Kortfors, Sweden	4,500	300	" "	" "
15. Halcomb & Co., Syracuse, U. S. A.	5,000	...	" "	Charged with molten pig.
16. The Nolde Electric Co., Baird, U. S. A.	5,000	...	" "	.....
17. The Firth Sterling Steel Co., McKeesport, U. S. A.	10,000†	...	" "	.....
18. Società Tubi Mannesmann, Dalmine, Italy	6,000†	736	" "	Charged cold. Product for seamless tubes.
19. " " " " "	6,000†	736	" "	

Three furnaces of this type are in use for the production of pig iron at Welland and Sault Ste. Marie, Canada, and Héroult-on-the-Pitt, California.

b. DU GIFFRE.

1. Société des Hauts-Fourneaux et Forges, Allevard, France	3,200	500	.....	.....
2. Société des Hauts-Fourneaux et Forges, Allevard, France	3,200	500	.....	.....

c. KELLER.

1. Holtzer & Co., Unieux, France	....	...	.....	Charged with molten steel.

* Not in use.

† Under construction.

Firm.	Capacity Kilogrammes.	Power Requirements, Kilowatts	Current.	Remarks.
d. GIROD.				
1. S. A. Electrométallurgique, Ugine, France.....	1,800	300	Single phase	Charged cold.
2. " " " "	2,000†	300	" "	" "
3. " " " "	2,000†	300	" "	" "
4. " " " " 8,000 to	10,000†	1,200	" "	Charged cold. Four electrodes.
5. " " " " 8,000 to	10,000†	1,200	.....	" "
6. Oehler & Co., Aarau, Switzerland.....	2,000	300	Single phase	For foundry. Charged cold.
7. Joh. Cockerill, Seraing, Belgium.....3,000 to	4,000†	450	" "	Produces special steels. Cold or molten charge.
8. A. Stotz, Stuttgart-Kornwestheim, Germany....	2,000†	300	" "	Charged cold. For steel castings.
9. Marrel Frères, Rive de Gier, France.....	....†	...	" "	.....
10. Ternitzer Eisen- und Stahlwerke, Ternitz, Austria	....†	...	.....	.....
e. STASSDNO.				
1. Bonner Fräserfabrik, G.m.b.h., Bonn, Germany	1,000	185	Three phase	Tool steel and steel castings. Current, 110 volts, 50 periods.
2. " " " " " "	1,000†	185	" "	" "
3. Forni Termoelettrici Stassano, Turin, Italy....	5,000	750	" "	Special steels and steel castings. Current, 150 volts, 50 periods.
4. " " " " "	5,000	750	" "	" "
5. " " " " "	900	180	" "	Special steels and steel castings, Current, 100 volts, 50 periods.
6. " " " " "	900	180	" "	
7. " " " " "	900†	180	" "	.....
8. " " " " "	400	75	" "	Steel castings. Current, 80 volts, 50 periods.
9. " " " " "	400	75	" "	" "
10. Imperial Arsenal, Turin.....	700	150	" "	Projectile and armor steel. Current, 80 volts, 50 periods.
11. " " "	700†	150	" "	" "

† Under construction.

THE GAYLEY DRY-AIR BLAST.

AN APPRECIATIVE ESTIMATE OF ITS TECHNICAL AND COMMERCIAL IMPORTANCE.

R. W. Raymond—American Institute of Mining Engineers.

TWO papers on the Gayley dry-air blast were presented at the recent meeting of the American Institute of Mining Engineers, the first, by Mr. Edward B. Cook, detailing experiences with the process at the Warwick furnaces, Pottstown, Pa., and the second, by Dr. R. W. Raymond, dealing with the technical and commercial improvements in blast-furnace management which are made possible by drying the blast. The former paper contains a great deal of very interesting and valuable information but since the results of the introduction of the Gayley process at the Warwick furnaces are dealt with at some length in Dr. Raymond's paper, the following review is devoted wholly to the latter.

It has been established beyond controversy that the use of the Gayley dry-air blast reduces the cost of pig iron about $1 per ton. The first reports of this direct economy were received with incredulity on both sides of the Atlantic. They were rejected as theoretically impossible according to generally accepted notions and formulæ. Dr. Raymond believes, however, that the accepted method of determining the economy of the blast-furnace process by means of thermo-chemical equations and heat balances, based as it is on averages which are assumed to represent uniform conditions, does not always furnish a safe criterion of alleged or possible technical economies. The method is scientifically sound but it is applied to data too roughly determined for such precise mathematical discussion. It is particularly lacking in that it fails accurately to take into account the grade of the iron produced, especially the "off iron" which is invariably a part of blast-furnace prod-

uct in present practice. Dr. Raymond offers this inaccuracy of methods of calculating blast-furnace economy as an explanation of the hasty conclusions of certain experts as to the impossibility of obtaining the reported technical economy of the Gayley process. The technical economy is, however, fully established and, Dr. Raymond says, "as regards commercial economy, there is no room for doubt or contradiction. If a blast furnace is 'running on' (*i. e.*, managed with the purpose of producing) a particular kind of pig iron, and if Mr. Gayley's process will deliver it altogether, or to an unprecedented degree, from the risk of producing incidentally another kind, not called for, and probably not desired or not readily salable at a profit, the commercial value of this insurance is beyond measurement by any technical formula that has been, or could be, constructed. The case presented in Mr. Cook's paper on 'Experience with the Gayley Dry Blast at the Warwick Furnaces,' furnishes a striking illustration of this proposition.

"As already observed, the testimony from iron works both in the United States and abroad agrees in declaring that the Gayley process reduces the cost of pig iron about $1 per ton; but this saving, though important, is trivial, compared with the commercial advantage of a more effective control of the operation and product of the furnace. To state the case roughly, the Warwick Iron & Steel Company was caught, with innumerable others, in the financial revulsion of 1907, which stopped for a time the market for pig iron. The company had a profitable contract with solvent customers for iron of a special grade; but the old and almost dilapidated furnace which it had kept in blast for the purposes of that contract was running so irregularly that only half—or less—of its product could be delivered under the contract, and the rest would have to be stored as not immediately salable, and, indeed, as never likely to be salable at a price covering the special expenses incurred for the purpose of producing the special, and more costly, grade of product for which the furnace had been burdened and operated.

"Under these circumstances, the interest on the capital represented by the 'off iron' would have exceeded the profits on the proportion of special iron delivered under the specifications of the contract; and a prudent manager would have been obliged to accept the unwelcome alternative (adopted, in fact, by most of our American merchant furnaces) of sacrificing his pending contract, blowing out his furnace, and submitting to the loss in general expenses, interest, etc., and the even greater damage caused by the scattering of skilled and trusted workmen and the inability to take immediate advantage of a general revival of business, or of a sudden special opportunity for a local resumption of work. These disastrous effects of a suspension of operations are, as I need scarcely say, those most dreaded by technical managers, since, besides their direct financial results, they involve the immeasurable anxiety and responsibility of efficient reorganization.

"Fortunately for the Warwick Company it had just completed the installation of an expensive plant for the Gayley process; and the operation of this plant, under all the disadvantages of new and untried apparatus, inexperience of both manager and workmen, and dilapidated condition of the furnace then in blast, enabled the company to raise the proportion of its immediately and profitably marketable product from below 50 to above 80 per cent.; to fill its pending contract; and to realize, instead of industrial demoralization and financial loss, a substantial profit from continued operations. Indeed, it is no secret that, through the total gains of this campaign, the entire cost of the installation of the Gayley system, including the sum paid for the patent right, was repaid in a few months, though the certified saving of $1 per ton in the average cost of pig iron would not by any means have accomplished that result in so short a time.

"The situation above described is one which any manager of a 'merchant' blast furnace (*i. e.*, a furnace selling its product to outside customers) may at any time encounter. But it carries a meaning also for establishments like the works connected with the United States

Steel Corporation and other great concerns, which have a use for the 'off iron' produced by their blast furnaces. For such 'off iron' could be manufactured at smaller expense than when it is turned out as an unwelcome by-product from a furnace charged and operated, at extra cost, to yield a more valuable product. In short, every blast-furnace manager knows that both technical and commercial economy as well as relief from personal anxiety, would be secured if he could only be sure of making what he is trying to make.

"This brings us back to the inquiry: What is the bearing of Mr. Gayley's invention upon this desirable element of certainty, through complete and intelligent control, in the operation of the blast furnace?

"As I have already observed, we have sought to secure such certainty through minute analyses of all the raw materials, etc., except the air of the blast, which weighs more than all the rest put together. But when we come to consider this element, we perceive at once that it cannot be usefully analyzed like ore, flux or fuel. We cannot determine its composition and then store it until we wish to use it; and if we could analyze it as it enters our blowing engines our knowledge would come too late to permit any effective action on our part, based upon such information. If we would attain that certainty of control which constitutes the perfection of an art, we cannot treat the air of the blast as we do all the other elements of the charge, which we regard as variables to the character of which we adjust our practice. The air, most variable of all, cannot be thus dealt with. We must make it practically a constant. Mr. Gayley has shown us that the only way to do this is to freeze the moisture out of it. No attempts at vague amelioration by partial measures will meet the case. What we want is, first, to know just what we are putting into the furnace through the blast, and, second, how we can continue to do that particular thing without variation.

"Mr. Gayley, after years of costly experiment, has shown us for the first time how to attain this object; and I am not surprised that leading ironmasters in this country and abroad have recognized his invention as the greatest advance in blast-furnace practice since the introduction of the hot blast by Neilson. It is scarcely too much to say that this invention, completing our mastery of conditions previously uncontrollable, has elevated the manufacture of pig iron from the category of processes which are partly art and partly accident to that of the true arts, which may be practiced with approximate scientific certainty."

THE POSSIBILITIES OF THE GASOLENE TURBINE.

AN ESTIMATE OF THE POSSIBLE COMBINED EFFICIENCY OF TURBINE AND COMPRESSOR.

Frank C. Wagner—American Society of Mechanical Engineers.

AN important contribution to the discussion of the possibilities of the gas turbine was made at the recent annual meeting of the American Society of Mechanical Engineers in a paper read before the Gas Power Section by Prof. Frank C. Wagner. Prof. Wagner presented no data obtained experimentally but his deductions from calculations based on theoretical considerations are in the highest degree interesting, since they indicate the possibility of attaining a combined efficiency of a gasolene turbine and a compressor which compares very favorably with the best results obtained with gasolene engines. We give a brief abstract of his paper. .

"Two methods of reducing the temperature of the gases themselves are possible. One method is to use an excess of air in burning the gas or gasolene, sufficient to keep the temperature of the gases after expansion in the nozzles within safe limits. The other method is to inject a liquid, preferably water, into the gases. The liquid absorbs heat, becoming superheated vapor, and the vapor furnishes work during expansion. It is the purpose of this paper to compare the above methods of reducing the temperature of the gases, and especially to consider how such a comparison is affected by variations in the efficiencies of the turbine and the air compressor.

"The cycle of the type of gasolene turbine here considered is similar to that of the Diesel engine, with complete expansion. The efficiency of this cycle may be readily found if both compression and expansion be assumed to be adiabatic. Since the net mechanical work done equals the difference between the heat absorbed and the heat rejected during a complete cycle," Prof. Wagner shows that the efficiency can be expressed by the following formula:

$$\text{Eff.} = 1 - \frac{T_1}{T_2} = 1 - \rho \frac{1-\gamma}{\gamma}$$

where T_1 is the absolute temperature of the air just before compression; T_2 the temperature at the end of compression; ρ the ratios of the pressures at the extremities of the adiabatic change—the compression pressure ratio—which is the same for the expansion line as for the compression line, assuming the expansion to be complete; and γ the ratio of the specific heats.

"The interesting feature of this expression for efficiency is that the theoretical efficiency depends only on the ratio of compression. It does not depend on the maximum temperature reached. Consequently, from a theoretical standpoint it makes no difference whether the fuel is burned with the theoretical amount of air or with a considerable excess. If a sufficient excess of air is used the temperature of the gases when they strike the turbine blades can be brought down to a value for which the strength of steel retains a high value.

"When practical efficiencies are considered, however, it is found that the proportion of air to fuel becomes important. Of the theoretical power that can be developed, only a fraction is actually converted into mechanical power. Consequently a much larger proportion of the available power must be consumed in compressing the air than is allowed in the theoretical expression for efficiency. The greater the proportion of air to fuel, the more will the practical efficiency fall off from the theoretical. The question arises whether with practicable mechanical efficiencies for the turbine and the compressor a sufficient excess of air can be used to bring down the temperature of the gases to a proper value and still give a reasonable efficiency for the complete operation."

Prof. Wagner has made a large number of calculations of the theoretical efficiency of the gas turbine under various conditions, and of total efficiencies for various mechanical efficiencies of turbine and compressor, and the results are incorporated in his paper in diagrams and tables which, unfortunately, we have not space to reproduce. A sample calculation is also shown. He has limited his consideration to the velocity stage type of turbine in which the gases may be expanded completely in a nozzle of refractory material before striking the wheel; this type he believes to be best suited for use as a gas turbine.

"The formula for theoretical efficiency indicates that high compressions are favorable to efficiency. To produce high compressions it is practically necessary to use two-stage or three-stage compressors. It occurred to the writer that it might be an advantage to use intercoolers between the stages of such compressors. Calculations have accordingly been made for the purpose of comparing the efficiencies obtainable with intercoolers and without them, with the general result that while theoretically the best efficiency is obtained by adiabatic compressions without intercoolers, yet with such values as are practically obtainable for the mechanical efficiencies of turbine and compressor the use of intercoolers is decidedly advantageous.

"Calculations have been made for a two-stage compressor having total compression ratios of 9 and 16, and for a three-stage compressor with a ratio of 27 for each of the three cases, first, when the compression is completely adiabatic, second, when the compression is adiabatic in each stage but the air is cooled between stages, and, third, when water is injected. . . . .

"A calculation of the total efficiencies for various efficiencies of turbine and compressor shows that a combination of water injection and intercooling gives a slightly higher total efficiency than water injection without intercooling. It is not

probable that both would be used in the same machine and consequently the calculations have been limited to the case of water injection with true adiabatic compression. . . . .

"An inspection of the diagrams shows that for all values of the mechanical efficiencies that seem obtainable at present, true adiabatic compression gives a lower total efficiency than either intercooling or water injection.

"It also appears that water injection gives a higher efficiency under some conditions than air dilution, while under other conditions the reverse is true. The diagrams show this very clearly. The slope of the total efficiency lines is such that the total efficiency line for water injection corresponding to a certain compressor efficiency may intersect the line for air dilution with intercooling corresponding to the same compressor efficiency.

"Comparing the diagrams for different compression ratios, not only are the total efficiencies greater for the higher pressures, but the relative effects of the different methods employed for keeping down the temperature of the gases upon the total efficiencies change decidedly.

"What can be expected of the gasolene turbine in practice?

"Air compressors of the piston type have been constructed which give a mechanical efficiency of 85 per cent. The best mechanical efficiency obtained with steam turbines is in the neighborhood of 65 per cent. Whether a velocity stage gas turbine of equal efficiency is possible can only be determined by actual trial. Some of the points of difference are as follows:

"In the steam turbine, the wheel revolves in gaseous mediums varying from a considerable density at the higher pressures to a very small density in the vacuum at the exhaust end. In the gas turbine, the gaseous medium is at atmospheric pressure, but on account of its high temperature the density will be only a little more than a third of that of air under ordinary atmospheric conditions. It is quite possible that the wheel friction will be no greater on the whole for a gas turbine than for the best steam turbine.

"The velocity of the gases leaving the expansion nozzle for a compression ratio of 27 would be about 4,600 feet per second, which is much higher than occurs in steam turbine practice. The effect of friction at such high velocities is yet to be determined. The experiments quoted by Professor Thomas in his book on Steam Turbines indicate that up to 220 pounds per square inch pressure the percentage of friction loss in a properly shaped nozzle diminishes with increase of pressure. If this law continues, the use of high jet velocities may not detract from the efficiency.

"It seems, therefore, within the range of possibilities to construct a gas turbine giving an efficiency of 60 per cent. and a three-stage air compressor of 85 per cent. efficiency. From the diagrams the combined efficiency for air dilution with intercooling is found to be 19.5 per cent., and for water injection, 15 per cent.

In Bulletin 191 of the U. S. Department of Agriculture, Lucke and Woodward detail tests of engines using gasolene and alcohol. The smallest fuel consumption with gasolene was about 0.7 pound of gasolene per brake horse power, obtained only with the most perfect adjustment in a very few tests. The average fuel consumption was nearer 1.25 pounds, which probably represents more nearly the average practice. A fuel consumption of 0.7 pound of gasolene per horse power corresponds to an efficiency of about 18 per cent., while a fuel consumption of 1.25 pounds of gasolene per horse power corresponds to a fuel efficiency of 10 per cent.

"The gasolene turbine appears to offer advantages in reliability, comparative simplicity of adjustments, and freedom from annoying troubles as compared with the explosion engine. Whether it can compete with the latter in power developed per unit of weight remains to be determined. A further advantage which the gasolene turbine has over the explosion engine is that the gasolene turbine can burn crude oil, which is a cheaper fuel."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Blackwell's Island.

The Safety and Carrying Capacity of the Blackwell's Island Bridge. Two Expert Reports. Reports of Henry W. Hodge and William H. Burr, setting forth in detail the condition of the structure. Also editorial. Ills. 13500 w. Eng News—Nov. 12, 1908. No. 232.

Stresses in the Blackwell's Island (Queensboro) Bridge Under Full Specified Loading. Gives stress sheet of Bolles and Hodge. 4000 w. Eng News—Nov. 19, 1908. No. 379.

The Method of Calculating Stresses for the Blackwell's Island Bridge, as Used in Bolles and Hodge's Recomputation. Explanation. 2000 w. Eng News—Nov. 19, 1908. No. 381.

Reports on the Blackwell's Island Bridge. A statement of the conclusions of experts appointed to investigate this structure. Also editorial. 4200 w. Eng Rec—Nov. 7, 1908. No. 144.

The Cantilever Without Suspended Span. Appendices to the reports on this bridge. 2500 w. Eng Rec—Nov. 21, 1908. No. 417.

We supply copies of these articles. See page 747.

Cantilever.

See Blackwell's Island, under BRIDGES.

Drawbridges.

Weaver Drawbridge Lift-Rail Locking. Illustrated description of this apparatus. 1200 w. Sig Engr—Nov., 1908. No. 280.

Earthquakes.

A Study of the Damage to Bridges During Earthquakes. William Herbert Hobbs. Read before the Am. Assn. for the Adv. of Science. Gives data from earthquakes of recent date. Ills. 5000 w. Jour of Geol—Oct.-Nov., 1908. No. 492 D.

Failures.

The Collapse During Reconstruction of a Span of the Baltimore & Ohio R. R. Bridge Across the Susquehanna. An illustrated account of this accident, describing the construction, the collapse, and the condition of the wreckage. 2500 w. Eng News—Oct. 1, 1908. No. 214.

Lift Bridges.

Electrically Operated Lift Bridge, the "New Bridge," at Cette (Le Pont Neuf, Pont-levant à Manœuvre Electrique au Port de Cette). M. Herrmann. Illustrated description of the construction and operating mechanism of this bridge, the middle span of which is lifted vertically to allow the passage of boats. 4300 w. Ann d Ponts et Chaussées—1908-III. No. 502 E + F.

Manhattan.

The Construction of the Manhattan Bridge Approaches. Illustrated description. 1500 w. Eng Rec—Nov. 21, 1908. No. 414.

The Manhattan Bridge Approach Viaducts. Illustrated detailed description. 2000 w. Eng Rec—Oct. 31, 1908. No. 27.

Pontoons.

Design and Construction of an Iron Pontoon Foot Bridge (Construction und Berechnung einer Schwimmenden eisernen Fussgängerbrücke). W. Schulz. Mathematical. Ills. Serial. 1st part. 1700 w. Elektrotech Rundschau—Oct. 17, 1908. No. 590 D.

Reinforced Concrete.

The Concrete Arch vs. the Concrete Girder Bridge. Frank Barber. Compares two recent reinforced concrete bridges as to efficiency and cost. Ills. 1200 w. Can Engr—Nov. 20, 1908. No. 404.

The Mill River Bridge of the New York, New Haven & Hartford Railroad. Illustrated description of this six-track railroad bridge, consisting of two arches of reinforced concrete. 2500 w. Eng Rec—Nov. 14, 1908. No. 255.

The Construction of the Pelham Bridge, New York. Illustrated detailed description of the general design and the construction operations of a concrete bridge with pile foundations. 2500 w. Eng Rec—Oct. 31, 1908. No. 20.

Some Reinforced Concrete Bridges in France. Illustrates and describes two railway and one foot bridge recently constructed, designed by M. A. Considère. 1500 w. Engr, Lond—Oct. 30, 1908. No. 197 A.

Steel.

Concerning High Unit-Stresses in Steel Bridge Design. Editorial on the tendency toward using higher unit-stresses, considering that there is no valid reason for the change. Also discusses the causes. 3000 w. Eng News—Nov. 19, 1908. No. 380.

Sydney Harbor Bridge. Describes a scheme which is to cost about £2,000,000. 1200 w. Engr, Lond—Nov. 6, 1908. No. 328 A.

Bridge Over the River Wear at Sunderland. Illustrated description of a double-deck bridge of unusually large proportions, and the methods of erection. Plates. 3500 w. Engng—Oct. 23, 1908. No. 76 A.

The Reconstruction of the Humboldt Bridge of the Berlin Railway (Die Auswechslung der Humboldthafenbrücke der Berliner Stadtbahn). Herr Wambsganss. Illustrates and describes important work in strengthening this steel bridge. Serial. 1st part. 4000 w. Glasers Ann—Oct. 1, 1908. No. 584 D.

See also Blackwell's Island, Failures, Manhattan, and Pontoons, under BRIDGES.

Timber.

Method and Cost of Constructing a Wooden King Post Truss Bridge with Concrete Abutments in Cuba. Charles M. Kercher. Description and cost data. Diagrams. 500 w. Engng-Con—Nov. 11, 1908. No. 240.

Transporter.

See Transporter Bridges, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

CONSTRUCTION.

Boring.

Test-Boring Methods. Investigations for New Bridges at Santa Cruz, Cal. James K. James. Illustrated description of drilling methods. 2500 w. Cal Jour of Tech—Oct., 1908. No. 343.

Brick.

See Stacks, under CONSTRUCTION.

Coal Bunkers.

Reconstructing Coal Bunkers in a Steam Power Plant. Explains the difficulties of work carried out in New York City in reconstructing coal bunkers destroyed by fire. 3200 w. Eng Rec—Nov. 14, 1908. No. 250.

Columns.

The Strength of Solid Cylindrical Round-Ended Columns. W. E. Lilly. Read at Dublin meeting of British Assn. for the Pro. of Science. Describes experi-

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ments made to determine the constants to be used in the formulae for their design. 4000 w. Engng—Nov. 13, 1908. No. 447 A.

The Crushing Strength of Concrete-Filled Steel Columns (Die Knickfestigkeit betongefüllter Mannesmann-Stahlrohrsäulen). A. Gessner. Gives results of tests. 2100 w. Beton u Eisen—Oct. 26, 1908. No. 571 F.

Concrete.

Methods of Constructing Concrete Vaults for Valves. Carroll Beale. Illustrates and describes economical method of construction. 800 w. Engng-Con—Nov. 18, 1908. No. 372.

Casting the Concrete Lions for Connecticut Ave. Bridge, Washington, D. C. Gives a view of one of the finished lions, and describes the methods used in casting. 1500 w. Eng News—Nov. 19, 1908. No. 374.

See also Foundations and Tunnels, under CONSTRUCTION; and Pavements, under MUNICIPAL.

Failures.

Failure of a Reinforced-Concrete Floor of Unusual Design. H. Alexis d'O. Saurbrey. An account of the failure of a new manufacturing plant in Cleveland, Ohio, and the repair work. Ills. 1300 w. Eng News—Nov. 5, 1908. No. 99.

Floors.

See Failures, under CONSTRUCTION.

Foundations.

Renewing Foundation of a Water Tank. William Martin. Describes work at Pittsburg where a timber foundation was replaced by concrete. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Oct., 1908. No. 349 D.

Substructure of Farmers' Loan & Trust Company's Building, New York. Illustrates and describes interesting details to meet conditions, and in the treatment of adjacent buildings. 2500 w. Eng Rec—Oct. 31, 1908. No. 19.

Foundations for the New Singer Building, New York City. T. Kennard Thomson. An illustrated detailed description of the construction of the pneumatic caisson foundations for this very tall building. 3500 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 488 E.

Foundations for the New Courthouse in Düsseldorf (Künstliche Fundierung des Geschäftsgebäudes für das Oberlandesgericht zu Düsseldorf). Franz Boerner. The first part deals with the examination of the ground. The foundation was of reinforced-concrete. Serial. 1st part. 2700 w. Beton u Eisen—Oct. 26, 1908. No. 573 F.

Foundations on a Solid Mass of Concrete Set in Bottomless Caissons on a Riprap Bed in a Swift Current (Fondations sur Massif de Béton immergé dans des Caissons sans Fond reposant sur un Lit d'Enrochements dans un Courant rapide). M. Armand. Describes method of constructing foundations for harbor works. Ills. 2000 w. Ann d Ponts et Chaussées—1908-III. No. 506 E + F.

Grain Elevators.

Grain Elevators (Etude sur les Magasins à Grains). M. Barbet. A general discussion of their design and equipment and a detailed description of the elevator at the port of Rosario. Ills. Serial. 1st part. 7500 w. Rev de Mécan—Oct., 1908. No. 520 E + F.

High Buildings.

The Skyscraper and the Street. David Knickerbacker Boyd. Discusses the present phases of the question and proposes a scheme for correcting most of the difficulties. Ills. 3000 w. Am Archt—Nov. 18, 1908. No. 358.

Masonry.

See Dams, under WATER SUPPLY.

Reclamation Work.

Building a City at Long Beach, Long Island. Illustrates and describes the work of converting 2000 acres of salt marsh, tidal channels and sand dunes into a fine residence city. 3000 w. Eng Rec—Nov. 21, 1908. No. 415.

Reinforced Concrete.

Is Concrete Steel a Permanent Construction? J. A. Fitzpatrick. A brief account of an unusual example of deterioration of steel framing in buildings. 600 w. Sci Am—Nov. 28, 1908. No. 472.

The Spacing of Reinforcement in Concrete Beams (Eisenabstände in Plattenbalken). B. Löser. Mathematical. Ills. 2100 w. Beton u Eisen—Oct. 26, 1908. No. 574 F.

Continuous Beams with Elastic Column Connections (Kontinuierlicher Träger mit elastisch verbundenen Stützen). Mario Genel. Mathematical. Ills. 4500 w. Beton u Eisen—Oct. 9, 1908. No. 575 F.

A Note on the Design of Rectangular Slabs (Ein Beitrag zur Berechnung der rechteckigen Platten). Jovo Simic. A mathematical discussion of stress distribution, etc. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 30, 1908. No. 583 D.

See also same title, under BRIDGES; Failures, Foundations, Retaining Walls, and Roofs, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Sewers, under MUNICIPAL; and Canals, Lighthouses, and Piers, under WATERWAYS AND HARBORS.

Retaining Walls.

The Construction of Reinforced-Concrete Retaining Walls (Die Konstruktion von Eisenbetonstützmauern). F. Baumstark. Mathematical. Ills. 2000 w. Beton u Eisen—Oct. 26, 1908. No. 572 F.

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Roofs.

A Flat Roof Supported by Reinforced-Concrete Beams (Solai a Travicelli di Cemento Armato, Soffittati in Piano). C. Marzocchi. Mathematical discussion of the design. Ills. 5500 w. Ann d Soc d Ing e d Arch Ital—Sept. 15, 1908. No. 539 F.

Stacks.

The World's Largest Chimney: 50 x 506 ft. Brick Stack for the Boston & Montana Smelter at Great Falls, Mont. States the requirements and gives an illustrated description of the design and construction. 4000 w. Eng News—Nov. 26, 1908. No. 639.

Steel.

Structural Features of the Pope Building, Cleveland, Ohio. Illustrates and describes interesting features due to difficult foundations and irregular plan. 1600 w. Eng Rec—Oct. 31, 1908. No. 21.

The Humboldt Savings Bank Building, San Francisco. C. Derleth, Jr. Describes building methods for this earthquake district adopted since the fire. Ills. 5500 w. Eng Rec—Nov. 21, 1908. No. 413.

See also Ferry Houses, under WATERWAYS AND HARBORS.

Tunneling Machines.

A Machine for Boring Rock Tunnels. Illustrated description of the Terry, Tench and Proctor Co.'s rock tunnel drilling machine. 1200 w. Eng News—Nov. 19, 1908. No. 378.

Tunnel Lining.

Method of Lining the Second Bergen Hill Tunnel of the Lackawanna Railroad. Describes the interesting forms used, the methods of bringing in the materials, and the excellent surface and alignment. 2500 w. Eng Rec—Oct. 31, 1908. No. 23.

Reinforced-Concrete Tunnel Lining in the Göttelborn Mine (Eisenbetonausbau einer Richtstrecke in der Königl. Steinkohlengrube Göttelborn, Saargebiet). W. Stark. Illustrated description of the work. 2200 w. Beton u Eisen—Oct. 9, 1908. No. 576 F.

Tunnels.

Special Concrete Structures, in the Hudson River Tunnels. W. M. Torrance. Illustrated description of the design and construction, with discussion. 9500 w. Jour W Soc of Engrs—Oct., 1908. No. 357 D.

The Tunnel of the New York, New Haven & Hartford Railroad at Providence, R. I. An account of railroad improvements, especially describing the tunnel, about 5,080 ft. long. Ills. 4500 w. Eng Rec—Nov. 7, 1908. No. 138.

Waterproofing.

Methods of Waterproofing Concrete Covered Steel Floors for Railway Bridges with Some Figures on Cost. Methods given in a committee report before a recent convention of the Assn. of Am. Ry. Supts. of Bridges and Buildings. Ills. 3000 w. Engng-Con—Nov. 4, 1908. No. 118.

MATERIALS OF CONSTRUCTION.

Cement Testing.

Report of the Committee on Testing Cement and Cement Products. E. S. Larned. From Pro. Nat. Assn. of Cement Users. On the use of cement blocks, giving standard specifications. 5000 w. Cement—Oct., 1908. No. 115 C.

The Micrographic Examination of Cement (Ueber migrographische Zementuntersuchung). Ernst Stern. Describes the utility of microscopic examination, methods used, etc. Ills. 3000 w. Stahl u Eisen—Oct. 21, 1908. No. 547 D.

Concrete.

Destruction of Concrete by Alkali. William P. Headden. Gives results of experiments. 2500 w. Colc Agri College, Bul. 132—Sept., 1908. No. 651 N.

Reinforced Concrete.

Tests on Reinforced Concrete Beams. E. Brown. Gives results of tests made at McGill University, during 1906-07. Ills. 20000 w. Can Soc of Civ Engrs—Oct. 15, 1908. No. 285 N.

Some Results of Recent Reinforced-Concrete Tests Made by the Firm of Dyckerhoff and Widmann (Einige Ergebnisse neuerer Eisenbeton-Versuche der Firma Dyckerhoff & Widmann A.-G.) W. Luft. Reports tests on beams. Ills. Serial. 1st part. 2200 w. Deutscher Bau—Oct. 14, 1908. No. 559 B.

Steel.

The Growth of the Angle Bar. M'Leod Thomson. Illustrated review of development and progress giving some new patterns thought to embody the most recent ideas. 2500 w. R R Age Gaz—Nov. 6, 1908. No. 127.

Timber Preservation.

A Primer of Wood Preservation. W. F. Sherfesee. Considers decay and how it can be retarded; and preservatives and processes used in the United States. 6000 w. U S Dept of Agri, Circ. 139—Feb. 8, 1908. No. 477 N.

MEASUREMENT.

Range Finders.

The Short-Base Range-Finder and Its Principles of Construction. H. Dennis Taylor. Discusses the principles, and the difficulties, and explains a new form of construction. 2500 w. Engng—Nov. 13, 1908. Serial. 1st part. No. 441 A.

Surveying.

See same title, under MINING AND METALLURGY, MINING.

Testing Laboratories.

The Testing Laboratory of the Bureau

We supply copies of these articles. See page 747.

of Sewers, Brooklyn, and Some Tests of Sewer Pipe. Describes the laboratory, its equipment and methods. Ills. 3000 w. Eng Rec—Nov. 21, 1908. No. 416.

MUNICIPAL.

Pavements.

Cement Sidewalks. Discusses materials and methods of construction. Ills. 1600 w. Munic Jour & Engr—Nov. 4, 1908. No. 84.

The Proper Construction of Brick Street Pavements. Will P. Blair. Read before the Am. Soc. of Munic. Imp. Points out the essentials of good brick pavements. 5000 w. Munic Engng—Nov., 1908. No. 345 C.

Refuse Disposal.

City Refuse and Its Disposal. H. deB. Parsons. Brief discussion of methods. 2500 w. Cal Jour of Tech—Oct., 1908. No. 344.

A New Refuse Destructor for West New Brighton, Borough of Richmond. New York City. Gives an official report by J. T. Featherston of a destructor recently put in operation. Ills. 3000 w. Eng News—Nov. 5, 1908. No. 98.

Operating Results of the Buffalo Refuse Utilization Plant. Illustrates and describes a successful plant and its operation. 2000 w. Eng Rec—Nov. 7, 1908. No. 141.

Utilization and Incineration of Household Refuse (Utilization et Incinération des Ordures Ménagères). Emile Burelle. Reviews methods of collection, transportation and utilization or destruction. Ills. 4000 w. Rev. d'Econ Indus—Oct. 16, 1908. No. 507 D.

Tests in Burning Various Kinds of Refuse in the Dörr Destructor (Verbrennungsversuche mit verschiedenen Müllarten im Dörrschen Müllverbrennungsofen). Gives results of tests. 3300 w. Gesundheits-Ing—Oct. 17, 1908. No. 587 D

Roads.

What the World's Roads Congress Deducted. W. F. Bradley. A review of the discussions and opinions advanced. Ills. 2200 w. Automobile—Nov. 5, 1908. No. 116.

Wear and Tear of Roads. W. J. Taylor. Read at Paris Int. Road Cong. Information concerning changes in material and maintenance adopted in England, and the improvements needed. 2500 w. Surveyor—Nov. 13, 1908. No. 424 A.

Effect of Traction Engine and Heavy Motor Traffic Upon Road Foundations. R. J. Thomas. Read at Paris Int. Road Cong. Information based on the examination of various English roads. 3500 w. Surveyor—Nov. 13, 1908. No. 426 A.

The Effect of Modern Traffic on Broken Stone Roads. L. W. Page. Read at Paris Int. Road Cong. Reports a study of this subject, giving results of tests. 2200 w. Surveyor—Nov. 13, 1908. No. 425 A.

The Future Road; Its Wearing Surface. Philip W. Henry. Read before the Int. Road Cong. Mainly a discussion of bituminous cement as a wearing surface. 3500 w. Eng Rec—Oct. 31, 1908. No. 22.

Labor Cost of Constructing Eight Macadam Roads and Data on the Average Labor Cost of Macadam Construction. Information concerning roads built by the Illinois Highway Commission. 4000 w. Engng-Con—Nov. 18, 1908. No. 373.

Modern Road Management. E. Purnell Hooley. Read before the Int. Road Cong. Discusses the construction of roads to meet changed conditions of self-propelled traffic, favoring the tarmac road. 2200 w. Eng Rec—Nov. 7, 1908. No. 140.

Petrolithic Pavement—An Improved Method of Oiled Road Construction. J C. Black. Describes the construction and the required outfit. 2500 w. Cal Jour of Tech—Oct., 1908. No. 341.

Septic Tanks.

Septic Tank Patents. Prof. A. Marston. Gives a brief review of their history and of court decisions. 3500 w. Munic Engng—Nov., 1908. No. 346 C.

Sewage Disposal.

Modern Methods of Sewage Disposal as Applied to Public Institutions. Frank Grove. Prize paper. Briefly considers the methods of treatment by irrigation, by chemical treatment, and biological filtration. Ills. 2200 w. Surveyor—Oct. 23, 1908. No. 64 A.

A New Method of Sewage Purification (Der Emscherbrunnen, ein neues Verfahren der Abwasserreinigung). P. Kurgass. Describes a system adapted to cities of moderate size. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 605 D.

Sewage Purification.

Sewage Purification versus Water Filtration. George C. Whipple. Read before the Am. Soc. of Munic. Imp. A discussion of the place and value of each, and the need of both. 2500 w. Eng Rec—Oct. 31, 1908. No. 24.

See also Purification, under WATER SUPPLY.

Sewers.

Reinforced Concrete Intercepting Sewer. Alexander J. Taylor. Illustrates and describes a sewer at Wilmington, Del., explaining the difficulties. 3000 w. Munic Jour & Engr—Nov. 18, 1908. No. 331.

The Water-Works and Sewerage of Monterey, Mex. Illustrated account of the water supply and main drainage works being constructed by Monterey Railway, Light and Power Company. Plate. 1500 w. Engr, Lond—Nov. 6, 1908. Serial. 1st part. No. 327 A.

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Street Grading.

The Seattle Regrade, with Particular Reference to the Jackson St. Section Louis P. Zimmerman. An illustrated description of the extensive re-grading and leveling of the hilly streets and adjacent property. 2200 w. Eng News—Nov. 12, 1908. No. 230.

WATER SUPPLY.

Analysis.

The Mineral Analysis of Water for Industrial Purposes and Its Interpretation by the Engineer. Herman Stabler. Presents simple calculations and formulae of assistance in classifying waters for industrial purposes. 5000 w. Eng News—Oct. 1, 1908. No. 211.

Conduits.

The Dulzura Conduit of the Southern California Mountain Water Co.; Extension of San Diego Water Supply. M. M. O'Shaughnessy. Illustrated description of the construction of a 13-mile open conduit, in connection with the water supply work for San Diego. 3000 w. Eng News—Nov. 26, 1908. No. 638.

Design of Conduits of Variable Diameter on the Basis of Maximum Economy of Material (Calcolo delle Condotte d'Acqua a Diametri Variabili in Base al Criterio della Massima Economia di Materiale). Mario Dornig. Mathematical and theoretical. Ills. 3000 w. Ann d Soc d Ing e d Arch Ital—Sept. 15, 1908. No. 540 F.

Dams.

The Closure of the Charles River Dam. Edward C. Sherman. An illustrated account of the dropping of the gates of the "shut-off" dam at Boston. 900 w. Eng News—Nov. 5, 1908. No. 102.

Construction of the Pathfinder Dam, North Platte Project, United States Reclamation Service. E. H. Baldwin. Illustrates and describes the construction of this masonry dam of the modified arch type. 2500 w. Eng Rec—Nov. 7, 1908. No. 136.

The Movable Dams and Lock at the Power Plant on the Chicago Drainage Canal. Plan and illustrated description of the locks and dams for controlling water flow and passing navigation at the Lockport, Ill., power plant. 3000 w. Eng News—Nov. 12, 1908. No. 231.

The Strength of Masonry Dams (Der Spannungszustand einer Staumauer). O. Mohr. Mathematical and theoretical. Ills. Serial. 1st part. 2700 w. Zeitschr d Oest Ing u Arch Ver—Oct. 2, 1908. No. 570 D.

Diversion Damages.

The Adjustment of Diversion Damages by Storage Compensation. Robert E. Horton. Describes English practice, discussing the difficulty of employing it in the United States. 7000 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 665 F.

Filtration.

Cincinnati's Water Filtration Plant. Illustrated description of the plant that gives the city a pure, clean, water supply. 2500 w. Munic Jour & Engr—Nov 4, 1908. No. 83.

The Torresdale Preliminary Filters of the Philadelphia Water Supply. Illustrates and describes mechanical filters for removing suspended particles without the use of a coagulant. 4500 w. Eng Rec—Nov. 14, 1908. No. 248.

See Sewage Purification, under MUNICIPAL; and Philadelphia, under WATER SUPPLY.

Fire Protection.

Calcium Chloride as a Preventative of Freezing in Automatic Sprinkler Systems. Rutger B. Green. Reports the successful use of this substitute for compressed air. 800 w. Eng News—Nov. 19, 1908. No. 376.

Fire Extinguisher Installation in the Milton Car House of the Boston Elevated Railway Company. Illustrated description of a system containing about 2400 sprinkler heads. 1200 w. Elec Ry Jour—Nov. 7, 1908. No. 109.

Insurance Rates and the Water Service. Frank A. Barbour. Describes improvements in supply for fire service that led to reduction in insurance rates. Discussion. 4500 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 665 F.

Ground Waters.

The Indirect Determination of the Capacity of a Spring (Determinazione Indiretta della Portata di una Sorgente). Carlo Fossa-Mancini. Illustrated mathematical description of method. 4500 w. Ann d Soc d Ing e d Arch Ital—Oct. 1, 1908. No. 541 F.

Notes on the Hygienic Aspect of the Breslau Ground Water Supplies (Gedanken über die Sanierung der Breslauer Grundwassergewinnungsanlagen). Dr. Lübrig. Discusses the quality of the water supply, purification methods, etc. Serial. 1st part. 8800 w. Gesundheits-Ing—Oct. 3, 1908. No. 586 D.

Irrigation.

Irrigation in South-Eastern Australia. Describes the conditions and the scheme of water regulation. 2500 w. Engr, Lond—Nov. 13, 1908. No. 449 A.

National Irrigation and Flood Control. Arthur P. Davis. Outlines the work of the Reclamation Service, discussing results thus far. 1200 w. Eng Rec—Nov. 14, 1908. No. 254.

London.

Private Water Supply in London. Explains present conditions and the excessive charges for water, and the ease of obtaining an artesian supply. Ills. 2000 w. Engng—Nov. 13, 1908. No. 443 A.

We supply copies of these articles. See page 747.

Meters.

Meters and Water Consumption of the Hartford Water Works. Ermon M. Peck. An account of the metering of the service pipes and the results. 1800 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 662 F.

Philadelphia.

The Water Supply of Philadelphia, with Special Reference to the Filtration Works Now Under Construction. John C. Trautwine, Jr. Describes conditions before the works were begun, discussing the plan adopted. 8000 w. Jour Fr Inst—Nov., 1908. No. 350 D.

Pipe.

Modern Welded Pipe for Water and Gas. F. N. Speller. Read before the Am. Gas Inst. Discusses the comparative value of wrought iron and steel pipe. 2800 w. Eng News—Nov. 5, 1908. No. 101.

Pipe Corrosion.

Electrolysis of Water Mains in Newark, N. J. From the report of William E. Foss, appointed to investigate the conditions. 2000 w. Eng Rec—Nov. 14, 1908 No. 251.

Pipe Joints.

Rubber Pipe Joints. Robert Spurr Weston. Describes this process, giving information regarding the method. Discussion 3500 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 664 F.

Pipe Lines.

The Sub-Aqueous Pipe and Electric Cable Way at Gloucester, Mass. Herman W. Spooner. Explains the conditions and gives an illustrated detailed description of the engineering work. 6300 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 661 F.

Purification.

Importance of the Proper Operation of Water and Sewage Purification Plants. George W. Fuller. Read before the Am. Soc. for Munic. Imp. Outlines features of operation necessary to secure efficiency. 3500 w. Eng Rec—Oct. 31, 1908. No. 26.

Rates.

Meter Rates. Walter H. Richards. Discusses the calculation of meter rates. General discussion. 8000 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 663 F.

San Francisco.

The Water Supply of San Francisco, Cal. C. E. Grunsky. Explains the problems, describing the works now in use and the proposed Tuolumne River project. Maps. 24000 w. Jour Assn of Engng Socs—Sept., 1908. No. 352 C.

Water Works.

Water-Works Valuation and Fair Rates, in the Light of the Maine Supreme Court. Decisions in the Waterville and Brunswick Cases. Leonard Metcalf. 25000 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 489 E.

Some Common Mistakes in the Construction and Maintenance of Water Systems. W. G. Yorston. Read before the Nova Scotia Soc. of Engrs. Discusses briefly the different parts of a water system, calling attention to mistakes in construction. 5000 w. Can Engr—Nov. 6, 1908. No. 154.

See also Accounting, under INDUSTRIAL ECONOMY.

Weirs.

The Design of Canal Diversion Weirs on a Sand Foundation. W. G. Bligh. Shows the means adopted to insure the safety of such structures. 5500 w. Can Engr—Oct. 30, 1908. No. 1.

WATERWAYS AND HARBORS.

Canals.

The Marne-Saône Canal (Le Canal de la Marne à la Saône). O. Jacquinot. The first part describes its position as a part of the French system of inland waterways, discusses its history and begins a description of the canal works. Ills. Serial. 1st part. 4500 w. Génie Civil—Oct. 10, 1908. No. 534 D.

Repair of the Chazilly Conduit of the Bourgogne Canal with Reinforced Concrete (Sur la Réfection de la Rigole de Chazilly du Canal de Bourgogne au Moyen de Chapes en Béton Armé). M. Hégly. Illustrated description of a reinforced-concrete lining applied to a trench supplying water to the Chazilly reservoir. 3000 w. Ann d Ponts et Chaussées—1908-III. No. 503 E + F.

Dredges.

See same title, under MARINE AND NAVAL ENGINEERING.

Dredging.

Methods and Costs of Dredging the St. Lawrence River. Describes the work and the outfit used, the methods of dredging, and gives itemized cost. 5000 w. Engng-Con—Nov. 4, 1908. No. 241.

Dry Docks.

See same title, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Estuary Channels.

Estuary Channels and Their Treatment. Brysson Cunningham. Describes the adequate maintenance of these approach channels to meet the requirements of modern commerce. Ills. 4500 w. Engng—Oct. 30, 1908. Serial. 1st part. No. 189 A.

Ferry Houses.

The Municipal Ferry House Substructure, New York. Illustrates and describes the fireproof steel structure at Battery Park which is to accommodate all the municipal ferries located at this point. 4000 w. Eng Rec—Nov. 7, 1908. No. 143.

Flood Prevention.

See Irrigation, under WATER SUPPLY.

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Flood Protection.

Flood Protection in Grand Rapids, Mich. An account of the extensive scheme for protection from floods in the Grand River. Ills. 5000 w. Eng Rec—Oct. 31, 1908. No. 25.

Floods.

The Floods of the Mississippi Delta: Their Causes, and Suggestions as to Their Control. William D. Pickett. 7800 w. Pro Am Soc of Civ Engrs—Nov., 1908. No. 647 E.

France.

France's Investment in Marine Transport Facilities, Harbors and Canals (Mise au Point de notre Outillage Maritime—Ports et Canaux). M. G. Hersent. An exhaustive discussion of marine and inland water transport in its relation to French industry. Ills. 28000 w. Bul Soc d'Encour—Oct., 1908. No. 518 G.

Great Lakes.

The Low Stage of Lakes Huron and Michigan. C. E. Grunsky. A study of the effect of water storage in Lake Superior upon the water elevation in Lakes Huron and Michigan, and a discussion of the causes of the low stages. 5500 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 487 E.

Lighthouses.

The Guiding Lights of Our Coasts. C. H. Claudy. Gives a diagram showing the relative intensities of lights of different orders and different characters, with other information regarding lamps and lighthouses. Ills. 1000 w. Sci Am—Nov. 28, 1908. No. 473.

An Open-Sea Ferro-Concrete Lighthouse. Illustrated description of a recently completed structure in the Straits of Malacca, and of the methods and difficulties of construction. 1000 w. Prac Engr—Nov. 6, 1908. No. 303A.

Locks.

See Dams, under WATER SUPPLY.

Ohio River.

The Proposed Reservoir System in the Ohio River Basin. M. O. Leighton. A reply to an article by Major H. C. Newcomer. 7000 w. Eng News—Nov. 5, 1908. No. 103.

The Improvement of the Ohio River. William L. Sibert. A review of the various engineering projects proposed for the improvement of this river. Ills. 13000 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 490 E.

Piers.

Reinforced-Concrete Piers in Baltimore Harbor. Illustrates and describes the type of construction used. 1000 w. Eng News—Oct. 1, 1908. No. 212.

River Regulation.

Forests and Reservoirs in Their Relation to Stream Flow with Particular Reference to Navigable Rivers. Discussion of the paper by H. M. Chittenden. 7500 w. Pro Am Soc of Civ Engrs—Nov., 1908. No. 650 E.

The Report of the Pennsylvania Water Supply Commission: Forests, Stream Flow, and Flood Control. Reviews points of special interest in the report relating to the three subjects referred to above. 1800 w. Eng News—Nov. 19, 1908. No. 377.

See also Ohio River, under WATERWAYS AND HARBORS.

Saint Nazaire.

The New Approach and New Harbor Works at the Port of Saint Nazaire (La nouvelle Entrée et les Travaux de Transformation du Port de Saint-Nazaire). M. Mallat. Describes recently completed works begun in 1896 to make this harbor on the west coast of France capable of accommodating the largest merchant and naval vessels. Ills. 2500 w. Ann d Ponts et Chaussées—1908, III. No. 501 E + F.

Water Powers.

The Use and Conservation of Water Power Resources. H. von Schon. This third and closing article of a series analyzes typical cases and suggests programmes for their development. 4000 w. Engineering Magazine—Dec., 1908. No. 674 B.

The Conservation of the Forests and Water Powers of Wisconsin. E. M. Griffith. An account of the work in progress and in prospect and its objects. Ills. Discussion. 6000 w. Jour W Soc of Engrs—Oct., 1908. No. 356 D.

The Water Powers of Sweden, Norway and Switzerland (Die Wasserkräfte Schwedens, Norwegens und der Schweiz). Eduard Engelmann. Gives detailed information of the hydraulic power available in these three countries and of present developments. Ills. Serial. 1st part. 4700 w. Zeitschr d Oest Ing u Arch Ver—Oct. 16, 1908. No. 581 D.

MISCELLANY.

Building Removal.

Note on the Work of Raising and Moving the Antwerp-Dam Station Building. Albert Morglia. Illustrated detailed description. 5800 w. Bul Int Ry Cong—Oct., 1908. No. 167 G.

Raising and Moving the Antwerp Station (Notes sur le Rehaussement et le Déplacement de la Station: Anvers-Dam). P. Deprez. Illustrated description of the work. 3000 w. All Indus—Oct., 1908. No. 526 D.

Contracts.

Loose Specifications and Dishonest Contracts. Editorial criticism of the framing of certain contracts. 1200 w. Eng News—Oct. 1, 1908. No. 213.

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ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

See Submarine Cables, and Telephone Cables, under COMMUNICATION.

Radio-Telegraphy.

Post-Graduate Lectures on Radio-telegraphy and Radiotelephony. Prof. J. A. Fleming Abstract of lectures being given at the University College, London. 1500 w. Engng—Oct. 30, 1908. Serial, 1st part. No. 191 A.

Recent Patents in Wireless Telegraphy and Telephony. W. H. Eccles. Considers recent patent specifications that deal with apparatus of importance or interest. Diagrams. 2000 w. Elect'n, London—Nov. 6, 1908. Serial, 1st part. No. 311 A.

The Artom System of Radiotelegraphy. From a paper by Prof. Alessandro Artom before the Italian Elec. Assn. Brief description of this system. Ills. 1800 w. Elec Rev, N Y—Nov. 28, 1908. No. 620.

The Actual State of Wireless Telegraphy (L'Etat Actuel de la Télégraphie sans Fil). The first part discusses the general theory and principles. Ills. Serial, 1st part. 2500 w. Génie Civil—Oct. 17, 1908. No. 535 D.

See also Hertzian Waves, under ELECTRO-PHYSICS.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Submarine Cables.

Injury to Submarine Cables by Steam Trawlers. Report of the Inter-Departmental Committee appointed to inquire into the injury caused by trawlers, and to suggest means of preventing such injury. 3800 w. Elect'n, London—Oct. 23, 1908 No. 74 A.

Telautograph.

A New Form of Telautograph. Dr. Robert Grimshaw. Illustrated description of Grazanna's apparatus and its action. 800 w. Sci Am—Nov. 21, 1908. No. 332.

Telegraph Offices.

The Reconstruction of the Vienna Central Telegraph Office (Der Umbau der Wiener Telegraphenzentrale). J. Jokisch. Detailed description of the new building. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 10, 1908. No. 577 D.

Telegraphy.

Diplex-Duplex Realisable by Means of Ordinary Instruments and Without Balance (Diplex-Duplex réalisable au Moyen des Appareils ordinaires et sans Balance). M. Henry. Illustrated description of method. 3500 w. Soc Belge d'Elecns—Oct. 1908. No. 510 E.

Telephone Cables.

Telephone Cables with Iron Wire Covering (Beitrag zur Berechnung von Fernsprechkabeln mit Eisendrahtumspinnung). Absalon Larsen. A mathematical discussion of the design of cables with increased inductance. Ills. 5000 w. Elektrotech Zeitschr—Oct. 22, 1908. No. 614 B.

Telephony.

The Development of Telephony. Sergius P. Grace. An illustrated review with discussion. 7400 w. Pro Engr's Soc of W Penn—Oct., 1908. No. 348 D.

The Condenser in Telephony. G. M. B. Shepherd. A short description of their use and applications in this field. 2200 w. Elec Engng—Nov. 5, 1908. No. 308 A.

The Central Battery System and its Application to Paris (Le Système Téléphonique à Batterie Centrale; son Application à Paris). Eugène H. Weiss. Illustrated description of the system, the conditions in Paris and proposals for their improvement. 4500 w. Génie Civil—Oct. 3, 1908. No. 532 D.

The Arrangement of Party Lines in Austrian Telephone Practice (Die Einrichtung der Gesellschaftsanschlüsse im österreichischen Telephonbetriebe). Karl Fuchs. Serial, 1st part. 3300 w. Elektrotech u Maschinenbau—Oct. 18, 1908. No. 595 D.

DISTRIBUTION.

Autotransformers.

The Autotransformer. R. H. Fenkhausen. Describes types and their applications. Ills. 1000 w. Power—Nov. 17, 1908. No. 292.

Industrial Plants.

Electrical Distribution Systems for Industrial Plants. Warren H. Miller. Why 440 volts is the preferred layout, with suggestions for its installation. 4000 w. Elec Wld—Nov. 7, 1908. No. 95.

Switchboards.

See same title, under GENERATING STATIONS.

DYNAMOS AND MOTORS.

A. C. Motors.

See Railway Motors, under DYNAMOS AND MOTORS.

A. C. Turbo-Generators.

Practical Considerations in the Selection of Turbo-Alternators. M. Kloss. Abstract of paper before the Manchester Loc. Sec. of Inst. of Elec. Engrs. Deals with ventilation, voltage regulation and power factor. 2500 w. Elect'n, London—Nov. 6, 1908. No. 315 A.

We supply copies of these articles See page 747.

Design.

Calculation of Wire for Shunt Field Circuit. A. M. Bennett. Gives chart for finding the nearest proper size of wire for a given m. m. f. in ampere-turns, shunt field voltage and number of poles. 900 w. Elec Wld—Nov. 14, 1908. No. 227.

Failures.

Typical Electric Motor Failures. Discusses a number of recent failures and ways of avoiding them. 2200 w. Elec Wld—Nov. 7, 1908. No. 96.

Railway Motors.

Alternating-Current Commutator Motors as Applied to Traction Work. M. Ostros. Abstract translation from *Elektrotechnische Zeit.* A report of an investigation of types. 1800 w. Elect'n, London—Oct. 23, 1908. Serial, 1st part. No. 73 A.

ELECTRO-CHEMISTRY.

Corrosion.

Rust. M. Thornton Murray. Read before the Staffordshire Iron & Steel Inst. Discusses theories of rust formation, influence of composition, protective measures, non-metallic rust preventives, etc. 5000 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 456 A.

Theory of Electrolytic Corrosion. A. F. Ganz. Explains the theory of electrolysis, and the way stray currents from electric railways cause electrolytic corrosion. 2500 w. Sib Jour of Engng—Oct., 1908. No. 353 C.

The Corrosion and Decay of Metals. J. T. Milton. Lecture at the Franco-British Ex. to the Inst. of Marine Engrs. Briefly considers the causes and the methods of protection, etc., showing that electric currents may be made to protect as well as to corrode. 3000 w. Mech Engr—Oct. 30, 1908. Serial, 1st part. No. 181 A.

The Attack of Iron by Water and Aqueous Solutions (Ueber den Angriff des Eisens durch Wasser und wässerige Lösungen). E. Heyn and O. Bauer. A report from the Imperial German Testing Station. Ills. 6000 w. Stahl u Eisen—Oct. 28, 1908. No. 548 D.

ELECTRO-PHYSICS.

Alternating Currents.

Non-Harmonic Alternating Currents. Dr. Benjamin F. Bailey. Calls attention to features of complex harmonic e. m. f. s. and currents. 2000 w. Elec Wld—Nov. 28, 1908. No. 634.

Hertzian Waves.

Hertz's Investigations on Electrical Waves (Ueber die Hertzschen Versuche mit elektrischen Wellen). L. Zehnder. Discusses the investigations and the theoretical and practical value of the results. Ills. 5000 w. Elektrotech Zeitschr—Oct. 15, 1908. No. 612 B.

History.

The History of Electrical Theories. P. Gruner. Abstract translation of a paper read before the Keplerbund at Frankfort. Traces the changes which discovery has wrought. 2000 w. Sci Am Sup—Nov. 28, 1908. No. 474.

GENERATING STATIONS.

Accumulators.

Storage Batteries. W. B. Kouwenhoven. Suggestions for their care and operation. Ills. 2000 w. Ry & Loc Engng—Nov., 1908. No. 10 C.

Researches on a Light Accumulator (Recherches sur un Accumulateur léger). Robert Goldschmidt. Describes researches on a zinc-potassium carbonate-nickel oxide cell. 4500 w. Soc Belge d'Elecns—Oct., 1908. No. 508 E.

Austria.

Details of Austrian Electrical Plants Built or Extended in 1906 and 1907 (Statistik der österreichischen Elektrizitätswerke welche im Jahre 1906 und 1907 erbaut und erweitert wurden). Tables. 4000 w. Elektrotech u Maschinenbau—Oct. 25, 1908. No. 596 D.

Central Stations.

Recent Central Station Developments at Hartford, Conn. Describes the plants and their equipment, discussing recent improvements. Ills. 3000 w. Elec Wld—Nov. 28, 1908. No. 633.

Producer Gas-Engine Central Station Plant. Illustrates and describes features of interest in the system at Keene, N. H. 2500 w. Elec Wld—Nov. 14, 1908. No. 225.

The Liège Power Station at Sclessin (La Centrale Electrique du Pays de Liège, à Sclessin). J. Izart. A 6,000 kw station driven by Parsons turbines. Ills. Serial, 1st part. 4000 w. L'Elecn—Oct. 3, 1908. No. 528 D.

Electric Light and Power Plants in Connection with the Altoona Power Station and the Ohlsdorf Stations and Shops (Elektrische Licht- und Kraftanlagen im Anschluss an das Kraftwerk Altona und der Betriebs- und Werkstätten-Bahnhof Ohlsdorf). H. v. Glinski. Illustrated detailed description. Serial, 1st part. 2500 w. Glasers Ann—Oct. 15, 1908. No. 585 D.

Cost.

The Progress of Electrical Design in Relation to the Reduction of Capital Cost. Miles Walker. Abstract of presidential address before the Manchester Local Section of the Inst. of Elec. Engrs. 2200 w. Elec. Engr, London—Nov. 13, 1908. No. 433 A.

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Economics.

Isolated Power Plant Costs and Their Relation to Central Station Service. W. F. Lloyd. An analysis of costs and discussion of rates. 2500 w. Elec Wld—Nov. 28, 1908. No. 635.

Hydro-Electric.

Hydro-Electric Plant in British Columbia. Illustrated description of the West Kootenay power scheme, with description of the region. 5500 w. Engr, Lond—Nov. 6, 1908. No. 326 A.

The Hydro-Electric Plant of the Uncas Power Company at Scotland, Conn. Illustrated description of a power development on the Shetucket River; the power to be transmitted to Norwich, 11 miles distant. 4500 w. Eng Rec. Nov. 21, 1908. No. 411.

Hydro-Electric Power Plant on the Piabanha River, Brazil. Illustrated description of one of the largest hydro-electric stations in South America. 1800 w. Elec Wld—Nov. 14, 1908. No. 224.

German 50000-Volt Transmission System. Illustrated description of a new municipal hydro-electric plant recently completed for the city of Munich. 3500 w. Elec Wld—Nov. 28, 1908. No. 632.

The Augst Water-Power Plant near Basel (Wasserkraftanlage Augst bei Basel). Josef Rosshändler. Illustrated description of this 30,000 horse power plant. 2500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 9, 1908. No. 580 D.

Hydro-Electric Plants on the Kerka River in Dalmatia (Hydroelektrische Anlagen am Kerkaflusse in Dalmatien). Hugo Tenzer. Illustrated description of several plants. Serial, 1st part. 1600 w. Elektrotech u Maschinenbau—Oct. 4, 1908. No. 593 D.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

Electric Power Plant of the Missouri State Penitentiary. Illustrated description of a plant practically operated by convict labor. 1700 w. Elec Rev, N Y—Nov. 14, 1908. No. 276.

Switchboards.

Switchboard Notes. S. Q. Hayes. Considers features in connection with projects requiring distant control, etc. 3000 w. Elec Age—Oct., 1908. No. 48.

See also Instruments, under MEASUREMENT; and Electric Power, under MINING AND METALLURGY, MINING.

Switch Gear.

The Reyrolle Ironclad Switch-Gear. Illustrates and describes a type of high-tension switch-gear consisting of separate ironclad units, hand-operated. 3000 w. Engng—Nov. 6, 1908. No. 323 A.

United Kingdom.

The Electric Power Companies of the United Kingdom and Their Prospects. G. L. Addenbrooke. A review of progress. 2200 w. Elec Rev, Lond—Oct. 23, 1908. No. 72 A.

LIGHTING.

Illumination.

The Absorption-of-Light Method of Calculating Illumination. A. S. McAllister. Outlines the method. 1000 w. Elec Wld—Nov. 21, 1908. No. 340.

Incandescent Lamps.

A German View of the Future of the Metal-Filament Lamps. A summary of their position as compared with rivals, as given by H. Remané in the E. T. Z. 700 w. Elec Rev, Lond—Oct. 30, 1908. No. 184 A.

Mercury-Vapor Lamps.

The Küch Quartz Mercury Vapor Lamp. O. Bechstein. Illustrated description of a lamp substituting quartz for glass. 1000 w. Sci Am Sup—Nov. 28, 1908. No. 476.

A New Carbon-Filament Mercury Vapor Lamp (Eine neue Kohlenfaden-Quecksilberlampe). Robert Hopfelt. Illustrated description and photometric curves. 3000 w. Elektrotech Zeitschr—Oct. 8, 1908. No. 609 B.

Progress.

Progress in Electric Lighting. Gives details of the newer metallic filament lamps and their use for street lighting, a résumé of arc lamp development, and interesting fittings for both. Ills. 10000 w. Elect'n, Lond—Nov. 13, 1908. No. 437 A.

Recent Progress in Electric Lighting (Les Récents Progrès dans le Domaine de L'Eclairage Electrique). M. L. Flesch. A general review. Ills. Serial, 1st part. 3000 w. L'Elecn—Oct. 24, 1908. No. 530 D.

Street.

Illumination of Seventh Avenue, Manhattan Borough, New York City. Illustrates and describes the installation chosen after many tests; arc lamps being considered as best meeting the conditions. 1400 w. Elec Wld—Nov. 7, 1908. No. 94.

Theatres.

Regulators for Stage Lighting (Bühnenregulatoren). V. Paetow. Illustrated description of various types of dimmers. 5000 w. Elektrotech Zeitschr—Oct. 22, 1908. No. 613 B.

POWER APPLICATIONS.

Dry Docks.

Electricity Applied to a Tyneside Dry Dock. Illustrated description of an up-to-date example of electrical equipment in shipyard work. 2500 w. Elec Rev, Lond—Oct. 23, 1908. No. 71 A.

We supply copies of these articles. See page 717.

Machine Tools.

See Electrical Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Printing Presses.

Two-Motor-Drive Web Printing Press, Manual Control. S. H. Sharpsteen. Discusses the essentials of web-press equipment. 3000 w Elec Rev, N Y—Nov. 7, 1908 No. 156.

Progress.

Recent Progress in the Applications of Electricity (Le Mouvement Récent des Grandes Applications de l'Electricite). Maurice Levy. Reviews progress in methods of transmission and utilization of electrical energy. 3500 w. Rev Gen d Sci—Oct. 15, 1908. No. 522 D.

Regulations

Police Regulations Governing the Installation, Operation and Supervision of Electrical Plants (Polizeiverordnung betreffend Einrichtung, Betrieb und Ueberwachung elektrischer Starkstromanlagen). Proposed by representatives of the German Assn. of Elec. Engrs. as alternative to the regulations of the Prussian Department of Commerce. Ills. 5000 w. Elektrotech Zeitschr—Oct. 15, 1908. No. 611 B.

Rolling Mills.

Electrically-Driven Brass and Copper Rolling Mills. C. A. Ablett. Abstract of paper read before the Birmingham Assn, of Mech. Engrs. An account of methods of driving such mills, describing a typical installation. 4500 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 459 A.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

Textile Mills.

Electrical Driving in Cotton Mills. W. H. Booth. An investigation of some of the misconceptions in respect to turning moments. 2500 w. Elec Rev, Lond—Nov. 13, 1908. Serial, 1st part. No. 435 A.

MEASUREMENT.

Barometer.

An Electrical Barometer (Un Baromètre électrique). Robert Goldschmidt. Illustrated description. Ills. 1500 w. Soc Belge d'Elecns—Oct., 1908. No. 509 E.

Dynamo Testing.

The Testing of Alternators. S. P. Smith. Abstract of a paper before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Shows the incorrectness of existing methods and explains an accurate method. 2200 w. Elect'n, Lond—Nov. 13, 1908. No. 436 A.

The Influence of Shaft Twist on the Measurement of Irregularity Factors. Mathematical explanation given by Moritz Kroll, in *Elektrotechnik und Maschinenbau.* 1000 w. Elec Engr, Lond—Nov 6, 1908. No. 309 A.

Hysteresis.

Experimental Determination of the Hysteretic Exponent. Nicholas Stahl. Shows how the hysteretic exponent may be evaluated. 500 w. Elec Wld—Nov. 21, 1908. No. 339.

Instruments.

Three-Phase Switchboard Instruments. E. P. Peck. Discusses the instruments necessary for showing the important factors. 2000 w. Elec Wld—Nov. 14, 1908. No. 228.

Measurements with Portable Instruments. F. P. Cox. Comments on conditions that influence such measurements, causes of error, accuracy, etc. 4000 w. Elec Age—Oct., 1908. No. 49.

Iron Losses.

A Method of Measuring Iron Losses in Bundles of Straight Strips. Robert Beattie. Describes experiments made to determine whether the wattmeter method proposed would work with short specimens. 3000 w. Elect'n, Lond—Nov. 6, 1908. No. 314 A.

Resistance.

The Construction and Measurement of High Resistance. Howard L. Bronson. Condensation of paper presented before the Am. Elec. Chem. Soc. Reports a study of this problem, and the difficulties. 2500 w. Elec Rev, N Y—Nov. 14, 1908. No. 277.

Speed.

The Development of Electrical Speed-Measuring Instruments (Die Entwicklung der elektrischen Fahrgeschwindigkeitsmessung). Paul Bautze. Illustrated description of types for railroads and automobiles. 5500 w. Elektrotech Zeitschr—Oct. 15, 1908. No. 610 B.

Transformer Testing.

Some Practical Notes on Transformer Testing. E. M. Wood. Notes based on experience of various methods. 2,000 w. Can Elec News—Nov., 1908. No. 223.

Units.

The Mercury Ohm. Shows the needless complications introduced by the present definition of the ohm, suggesting the amendment. 1500 w. Prac Engr—Nov. 6, 1908. No. 302 A.

TRANSMISSION.

Conduits.

Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY.

Fault Location.

Practical Fault Localizing on Electric Supply Networks. E. P. Austin. A short account of fault localization on a system without a cable-testing outfit. 800 w. Elec Rev, Lond—Nov. 13, 1908. No. 434 A.

We supply copies of these articles. See page 747.

Lightning Arresters.

Methods of Guarding Against Lightning. W. T. Ryan. Describes four types of arrester. 1200 w. Power—Nov. 17, 1908. No. 293.

Methods of Guarding Against Lightning. W. T. Ryan. Illustrates and describes different types of lightning arresters, discussing the essential features. 1500 w. Power—Nov. 10, 1908. No. 163.

Line Construction.

Overhead Construction. H. B. Gear and P. F. Williams. Discusses distributing line work and accessories. Ills. 5800 w. Elec Age—Oct., 1908. No. 47.

Protective Relays.

A New System of Sub-Station Relays for Incoming Transmission Lines. Paul MacGahan. Brief description of devices previously used, with reasons for their failure to give complete protection, with description of the latest device for this purpose. 2500 w. Elec Jour—Nov., 1908. No. 209.

Substations.

Apparatus for Direct-Current Substation. E. W. Allen. Abstract of paper read before the Assn. of Edison Ill. Co. Concerning the advantages and disadvantages of the different machines used. 2200 w. Elec Wld—Nov. 14, 1908. No. 229.

Transformers.

Characteristics and Uses of Transformers. R. H. Fenkhausen. Considers their selection and care, how to connect them up, etc. Ills. 1500 w. Power—Nov. 3, 1908. No. 41.

The Parallel Operation of Transformers. J. Murray Weed. A study of the distribution of current, losses, and action. 3500 w. Elec Wld—Nov. 21, 1908. No. 337.

Parallel Operation of Stationary Transformers. H. Bewlay. Gives a method of calculating the loading of each transformer and an investigation of the probable errors. 800 w. Elec Wld—Nov. 21, 1908. No. 338.

Interconnections of Transformers in Four-Wire Three-Phase Systems. K. Faye-Hansen. Diagrams of connections, with explanatory notes. 1000 w. Elec Wld—Nov. 28, 1908. No. 636.

The Distribution and Conduction of Heat in an Annular Plate (Ueber die Verteilung und Leitung der Wärme in einer kreisringförmigen Platte). Karl Kohler. Refers principally to methods of improving the temperature conditions of transformers. Ills. 3200 w. Elektrotech u Maschinenbau—Oct. 18, 1908. No. 594 D.

See also Transformer Testing, under MEASUREMENT.

Voltage Regulation.

Alternating-Current Feeder Regulators. W. S. Moody. Considers types of regulators and their control. Ills. Discussion. 5500 w. Pro Am Inst of Elec Engrs—Nov., 1908. No. 667 D.

MISCELLANY.

Exhibitions.

Electrical Exhibition at Manchester, England. Sidney Ransom. A general survey, with illustrations. 1200 w. Elec Wld—Nov. 14, 1908. No. 226.

INDUSTRIAL ECONOMY

Accounting.

The Accounting of Industrial Enterprises. William M. Lybrand. Discusses pools, trusts, holding companies, advantages of combination, evils of monopoly, etc. 3000 w. Jour of Acc—Nov., 1908. Serial, 1st part. No. 478 C.

Establishment Expenses and Their Relation to Cost Accounts. Henry Spencer. An examination and comparison of alternative general practices. 2000 w. Engr, Lond—Nov. 13, 1908. Serial, 1st part. No. 451 A.

The Office, Accounting and Cost-Keeping System; Department of Greater Water Supply, Peoples Water Company, Oakland, Cal. Langdon Pearse. Explains the system used and the conditions. 4000 w. Eng Rec—Nov. 14, 1908. No. 253.

Foundry Accounting Methods. John Doughton. Read before the Phila. Found. Assn. Discusses the proper handling of customers' orders. 3000 w. Ir Age—Nov. 12, 1908. No. 217.

A Model Foundry Accounting System. R. W. McDowell. Explains method of recording orders, billing, and charging. 1800 w. Foundry—Nov., 1908. No. 55.

Apprenticeship.

Apprenticeship Training. The report of C. W. Cross to the Master Mechanics' Assn. on the progress made in the apprenticeship systems for railroad shops. 3000 w. Boiler Maker—Nov., 1908. No. 13.

Practical Results from a Modern Apprenticeship System. C. W. Cross. Concerning results obtained from the apprenticeship system of the New York Central lines. Also discussion. 6500 w. Pro Ry Club of Pittsburgh—Sept. 25, 1908. No. 204 C.

We supply copies of these articles. See page 747.

Cost Systems.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This third article of a series enumerates and classifies the elements entering into production costs. 5000 w. Engineering Magazine—Dec., 1908. No. 677 B.

Depreciation.

Repairs, Renewals, Deterioration and Depreciation of Workshop Plant and Machinery. James Edward Darbishire. Suggestions for a system which shall provide for proper upkeep and replacement. 3300 w Inst of Mech Engrs—Oct. 16, 1908. No. 18 N.

Education.

The Training of Engineers. Inaugural address of Prof. Charles Frewen Jenkin, delivered at Oxford Univ. 5000 w. Mech Engr—Nov. 13, 1908. No. 431 A.

The Education of a Marine Engineer. W. E. Dalby. Reviews marine educational systems, particularly in England. 3000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 389 D.

The Relative Positions of Manual Training, Trade Training and Technical Education. Brief discussion of the work of each and their relation to each other. 2000 w. Am Mach—Vol. 31, No. 46. No. 221.

Technical and University Education (L'Enseignement technique dans ses Rapports avec l'Enseignement universitaire). Henry Le Chatelier. Reviews conditions in France. 3000 w. Rev de Métal—Oct., 1908. No. 517 E + F.

Eight-Hour Day.

The Eight-Hour Day and Sunday Rest in Mining (Zur Enquete über den Achtstundentag und die Sonntagsruhe beim Bergbau). Heinrich Reif. A German view of the question. Serial, 1st part. 1800 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 10, 1908. No. 550 D.

Engineers.

The Engineer as a Cultured Specialist. Alex. C. Humphreys. Address delivered at the inauguration of President Sparks, of Penn. State College. 3500 w. Stevens Ind—Oct., 1908. No. 485 D.

Industrial Legislation.

Some Medical and Insurance Problems Arising Out of Recent Industrial Legislation. Thomas Oliver. Some effects of the Workmen's Compensation Acts in Great Britain are discussed. 5000 w. Col Guard—Nov. 20, 1908. No. 736 A.

Management.

The Basic Cause of Increased Efficiency. Walter M. McFarland. Argues that increased efficiency is to be obtained principally through the stimulation of the human element by rewards. 3000 w. Engineering Magazine—Dec., 1908. No. 668 B.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This sixth article of a series discusses the modern theory of cost accounting. 5000 w. Engineering Magazine—Dec., 1908. No. 669 B.

The Profit-Earning Casting Plant. H. Cole Estep. Calls attention to possible economies. Ills. 2000 w. Foundry—Nov., 1908. No. 58.

An Automatic Follow-Up System. Read before the Phila. Found. Assn. Describes a system of keeping records of orders in the foundry and laying out work for the moulders. 2500 w. Foundry—Dec., 1908. No. 759.

Training Workmen in Habits of Industry and Coöperation. H. L. Gantt. Outlines a system discussing the application, obstacles, etc. 4500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 652 F.

Securing the Co-operation of the Workman in the Improvement of Workshop Methods, etc. R. W. Kenyon. Abstract of paper before the British Found. Assn. Gives an outline of the scheme in operation at Accrington and discusses the subject generally. 6500 w. Mech Engr—Oct. 23, 1908. No. 69 A.

Staff Organization in Large Manufacturing Plants. W. H. A. Robertson. Points out inefficiencies due to indefiniteness of authority and the overlapping of duties. 1000 w. Ir & Coal Trades Rev. Nov. 6, 1908. No. 329 A.

See also Accounting, Cost Systems, and Depreciation, and Wages under INDUSTRIAL ECONOMY; and Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Marine Transport.

Japan Winning the Pacific. Edward G. Bogart. Discusses the probability of Japan winning because of cheap ships, cheap labor, and cheap food. Maps. 3500 w. World's Work—Nov., 1908. No. 29 C.

Patents.

The American Patent Law. John D. Morgan. Discusses its attitude toward inventors. 2500 w. Ir Age—Nov. 5, 1908 Serial, 1st part. No. 87.

Wages.

Systems of Wages and Their Influence on Efficiency. Carl Bender. Shows the nature, effect and limits of the best known wage systems. 4000 w. Engineering Magazine—Dec., 1908. No. 680 B.

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MARINE AND NAVAL ENGINEERING

Ammunition.

Smokeless Powder. Conclusions of the Commission appointed to investigate the disaster on the Jena. 2500 w. Engng—Oct. 30, 1908. No. 193 A.

Battleships.

The Russian Cruiser-Battleship Rurik. Benjamin Taylor. Illustrated description of the vessel and its equipment, with report of trials. 1200 w. Int Marine Engng—Nov., 1908. No. 7 C.

A Measure of the Values of Warships. Sidney G. Koon. An illustrated article discussing a comparative basis for the military value of naval vessels. 1500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 395 D.

The Design of Modern Warships. Prof. J. J. Welch. Outlines developments affecting warship design and some types of war vessels, tracing the progress and reviewing the principles underlying their design. Ills. 8500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 385 D.

Modern Armored Ships (Les Cuirassés Modernes). A. Croneau. The first part discusses the evolution of the armored vessel, with especial reference to offensive power. Ills. Serial, 1st part. 6300 w. Rev Gen d Sci—Oct. 15, 1908. No. 523 D.

British Navy.

The Future of the British Fleet in Its Relation to the Two-Power Standard. Archibald S. Hurd. An explanation of the "Two-Power Standard," and its development. Ills. 5000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 387 D.

Compasses.

Deviation of the Compass Aboard Steel Ships and its Avoidance and Correction. L. H. Chandler. A statement of the general mathematical principles involved with illustrations from the results obtained aboard the vessels of the U. S. battleship fleet. Plates and tables. 16500 w. Soc of Nav Archts and Marine Engrs, No. 6—Nov., 1908. No. 265 N.

Condensers.

Steam Condensing Plant for Cargo Steamers. D. B. Morison. Illustrates and describes recent improvements. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 401 D.

Cruisers.

The Oldest Iron Ship in the World. Henry Penton. An account of the U. S. Man-of-War Michigan, in service on the Great Lakes. 1200 w. Soc of Nav Archts and Marine Engrs, No. 1½—Nov., 1908. No. 287 N.

Trials of the U. S. Scout-Cruiser Chester. Charles P. Wetherbee. Reports trials of a cruiser fitted with Parsons turbines. Plates. 1000 w. Soc of Nav Archts & Marine Engrs, No. 10—Nov., 1008. No. 271 N.

U. S. Scout-Cruiser Birmingham. Theo. C. Fenton. Illustrations, with description of machinery and report of official trials. 3500 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 660 H.

U. S. Armored Cruiser North Carolina. Theo. C. Fenton. Illustrations, with description of machinery and official trials. 4500 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 657 H.

Dockships.

German Naval Dockship Vulkan. Brief illustrated description of a vessel for docking and salving submarines. 400 w. Engr, Lond—Oct. 30, 1908. No. 199 A.

Dredges.

Sea-Going Suction Dredges. Thomas M. Cornbrooks. Describes dredges for the Engineer's Department of the U. S. Army. Plates. 500 w. Soc of Nav Archts & Marine Engrs., No. 15—Nov., 1908. No. 269 N.

Bucket Dredges (Die Eimerkettenbagger). R. Richter. General discussion of their design. Ills., Serial, 1st part. 3200 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 603 D.

Dry Docks.

The Influence of Free Water Ballast upon Ships and Floating Docks. T. G. Roberts. A discussion of the stability and strength. Plates. 6000 w. Soc of Nav Archts & Marine Engrs, No. 7—Nov., 1908. No. 266 N.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

The Electrical Plant and Means of Interior Communication of a Modern Ocean-Going Passenger and Cargo Vessel. Charles J. Dougherty. Describes the plant installed on the new steamship "Momus." 8000 w. Marine Rev—Nov. 5, 1908. No. 151.

Fire Boats.

Centrifugal Pump Fire Boats. Charles C. West. Gives the result of a test made on the first of two 9,000-gallon boats just delivered to the city of Chicago. Plates. 1700 w. Soc of Nav Archts & Marine Engrs, No. 14—Nov., 1908. No. 273 N.

Floating Cranes.

Twin-Screw Floating Cranes. Illus-

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trates and describes cranes recently built for the Argentine Government. 1500 w. Engng—Nov. 13, 1908. No. 445 A.

Gas Engines.

Gas Engine Experiments on H. M. S. Rattler. The Marquis of Graham. A report of recent trials. Ills. 1500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 399 D.

Gasoline Engines.

The Internal-Combustion Engines. W. G. Winterburn. A description of the gasoline engine as used for propelling small vessels. 2200 w. Marine Rev—Nov. 5, 1908. No. 153.

Marine Gasoline Engine Design. E. W. Roberts. Points out some special requirements for designing marine petrol engines according to modern ideas. Ills. 3500 w. Int Marine Engng—Nov., 1908. No. 6 C.

German Navy.

The Naval Policy of Germany, Its Progress and Aims. Count Ernst von Reventlow. An illustrated review of the progress and aims of the German sea power. 6000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 388 D.

Internal-Combustion Engines.

Internal Combustion Engines for Marine Purposes. Sir John L. Thornycroft. An illustrated article showing the increasing use of gas power for propulsion. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 402 D.

International Competition.

The Contest for Ocean Supremacy. Lawrence Perry. An account of preparations by German steamship companies to build faster ships than any now afloat, and the probability of still faster British liners. Ills. 6000 w. World's Work—Nov., 1908. No. 28 C.

Motor Boats.

The British International Trophy Race of 1908. W. P. Stephens. Reviews earlier races of motor-boats, describes the boats entered, and gives report of the 1908 race. Plates. 6500 w. Soc of Nav Archts & Marine Engrs, No. 16—Nov., 1908. No. 274 N.

Oil Fuel.

Oil Burning on Board Ship. Andrew Laing. An illustrated discussion of the importance and practicability of the use of liquid fuel. 3000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 394 D.

Ordnance.

Naval Ordnance. A. Trevor Dawson. An illustrated study of modern naval artillery. 4500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 397 D.

Progress.

Advances in Marine Engineering. James Denny. Abstract of presidential address at the Inst. of Marine Engineers. 4000 w. Mech Engr—Nov. 6, 1908. No. 307 A.

Propellers.

Theory of the Screw Propeller. von J. W. Haeussler. The mechanics of the design of the screw. 7000 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 658 H.

Further Propeller Analysis. Clinton H. Crane. Outlines the method used. Plates. 400 w. Soc of Nav Archts & Marine Engrs, No. 5—Nov., 1908. No. 270 N.

Resistance.

Further Experiments Upon Longitudinal Distribution of Displacement and Its Effect Upon Resistance. Herbert C. Sadler. Gives particulars of recent experiments in this field. Plates. 1400 w. Soc of Nav Archts & Marine Engrs, No. 4—Nov., 1908. No. 264 N.

The Influence of Midship-Section Shape Upon the Resistance of Ships. D. W. Taylor. Gives information obtained from experiments at the U. S. Model Basin during the past year. Plates. 2000 w. Soc of Nav Archts & Marine Engrs, No. 3—Nov., 1908. No. 263 N.

Rudders.

Clyde Rudders and Rudder Posts. Sketches and descriptions of general practice. 1800 w. Int Marine Engng—Nov., 1908. No. 5 C.

Shipbuilding.

America's Greatest Shipbuilding Establishment. Illustrated description of the plant of the Newport News Shipbuilding & Dry Dock Co. 2500 w. Naut Gaz—Nov. 12, 1908. No. 239.

Shipbuilding on the Great Lakes. Robert Curr. Describes a vessel of the hopper type being built on the mold system. Ills. 5000 w. Soc of Nav Archts & Marine Engrs, No. 12—Nov., 1908. No. 272 N.

The Shipbuilding and Engineering Company of Burmeister & Wain. Axel Holm. Illustrated description of this plant at Copenhagen, Denmark. 1500 w. Int Marine Engng—Nov., 1908. No. 2 C.

Shipbuilding Cranes (Hellingkrananlagen). W. Laas. The first part is devoted principally to examples in American shipyards. Ills. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1908. No. 600 D.

Ship Design.

The Shearing Strength of Riveter Seams in Shell Plating. R. E. Anderson. Explains shearing forces and methods of calculation. 3000 w. Int-Marine Engng—Nov., 1908. No. 3 C.

Notes on Naval Science Topics. Arthur R. Liddell. Explains a method of approximately determining the stability of vessels of full form. 2500 w. Int-Marine Engng—Nov., 1908. No. 4 C.

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Ship Repairing.

The Repair and Maintenance of Ships. C. H. Hall and S. H. Bunnell. Illustrates and describes interesting emergency work in shipyards. 3000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 390 D.

Ships' Bottoms.

Electric Scrubber for Cleaning Ships' Bottoms Without Dry Docking. Illustrated description. 900 w. Sci Am—Nov. 7, 1908. No. 105.

Ship Testing.

Practical Methods of Conducting Trials of Vessels. Colonel E. A. Stevens. Brief explanation of the system in use in the U. S. Navy. Plates. 1500 w. Soc of Nav Archts & Marine Engrs, No. 2—Nov., 1908. No. 262 N.

Speed.

The Influence of the Depth of Water on Speed. A. F. Yarrow and W. W. Marriner. An illustrated article on the behavior of high-speed boats in shallow water. 2000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 398 D.

Steam Boilers.

Gunboat Boilers. Charles S. Linch. Illustrated description of boilers installed on the Wilson Line steamboats. 1800 w. Boiler Maker—Nov., 1908. No. 12.

The Development of the Marine Boiler (Ueber die Entwicklung der Schiffskessel). F. Romberg. A general review of recent progress. 2500 w. Schiffbau—Oct. 28, 1908. No. 563 D.

Steam Engines.

The Mechanical Efficiency of Marine Engines. Refers to paper by J. Hamilton Gibson on "Torsion Meters in Marine Work," and discusses the determination of torque in shafting. Ills. 2000 w. Engr, Lond—Nov. 13, 1908. No. 450 A.

Piston Engines versus Turbines on the Atlantic. R. Caird. A comparative study of engine and turbine efficiency. 1500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 396 D.

The Development of the Modern Marine Engine. J. W. Reed. Illustrated description of the latest practice in the powering of steamships. 7500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 393 D.

Steamships.

The Design of Fast Ocean Steamers. E. W. De Rusett. An illustrated review of the progress and development. 5000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 391 D.

The Design and Building of Modern Cargo Steamers. S. J. P. Thearle. States the requirements of such vessels, and describes methods of British shipbuilders, illustrating vessels in different stages of construction. 4000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 386 D.

Some Recent Inventions as Applied to Modern Steamships. W. Carlile Wallace. Remarks on recent inventions that tend to increase safety and comfort of passengers. Plates. 5000 w. Soc of Nav Archts & Marine Engrs, No. 8—Nov., 1908. No. 267 N.

The Steamer Commonwealth. Warren T. Berry and J. Howland Gardner. Illustrations, drawings, and description of a vessel for night service between New York and Fall River. 3000 w. Soc of Nav Archts & Marine Engrs, No. 13—Nov. 1908. No. 286 N.

Service Test of the Steamship Harvard. C. H. Peabody, W. S. Leland and H. A. Everett. Plates. 1500 w. Soc of Nav Arcts & Marine Engrs, No. 9—Nov., 1908. No. 268 N.

The New Mallory Line Steamship Brazos. Illustrated detailed description of a fine steamship for service between New York and Galveston, Texas, and its performance. 5000 w. Naut Gaz—Nov. 12, 1908. No. 238.

The Great Ore Carriers on the Great Lakes. James Cooke Mills. Illustrates and describes special methods of construction used. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 392 D.

The Triple-Screw Turbine-driven Pacific Liner "Tenyo Maru." Illustrated detailed description of this first of these sister ships for the Oriental Steamship Co., of Japan. 7500 w. Plates. Engng—Oct. 30, 1908. No. 195 A.

The Turbine Steamship "Tenyo Maru." (Der Turbinendampfer "Tenyo Maru"). W. Kaemmerer. Illustrated description of this new vessel of the Japanese merchant marine. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 17, 1908. No. 602 D.

The First Year's Operation of the "Kronprinzessin Cecilie," the "Lusitania" and the "Mauretania." (Die Schnelldampfer "Kronprinzessin Cecilie," "Lusitania" and "Mauretania" im ersten Betriebsjahre). S. Bock. A comparison of service results. 5200 w. Schiffbau—Oct. 14, 1908. No. 562 D.

Steam Turbines.

Some Remarks on the Steam Turbine. J. W. Powell. Explains the principles of the action and reaction turbines, and gives a brief historical review of the development. Plates. 4200 w. Soc of Nav Archts & Marine Engrs, No. 11—Nov., 1908. No. 288 N.

Recent Developments in the Marine Steam Turbine. R. J. Walker. A review of progress in turbine propulsion in merchant and naval vessels. Ills. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 400 D.

See also Steam Engines and Steamships, under MARINE AND NAVAL ENGINEERING.

We supply copies of these articles. See page 747.

Submarine Mines.

Submarine Mines and Mining. Richmond P. Davis. Describes these mines and methods of mining, discussing in detail the factors and their use in harbor defense. Ills. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 659 H.

Submarines.

Transportation of Submarines. W. J. Baxter. Describes an actual, successful and economical solution of the problem of over-sea transportation of submarines. 4 plates. 1000 w. Soc of Nav Archts & Marine Engrs, No. 17—Nov., 1908. No. 275 N.

Submarine Naval Warfare. G. Laurenti. An illustrated review of the development of the submarine boat. 5500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 403 D.

See also Dockships, under MARINE AND NAVAL ENGINEERING.

Tank Steamers.

Holmes' Tube Tanker—A New Form of Construction for Tank Steamers Carrying Petroleum in Bulk. Samuel Holmes. Explains the main features of a new form proposed. 2500 w. Marine Rev—Nov. 5, 1908. No. 152.

Torpedo Boats.

Surface or Submarine Torpedo Boats. Brief discussion of their development, claims and performance. 2000 w. Engr, Lond—Nov. 13, 1908. No. 448 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Axles.

Bevel-Geared Live Back Axles for Motor Cars. Discusses important points in their design, methods of construction, certain defects, and related matters. Ills. 4000 w. Engng—Nov. 6, 1908. Serial, 1st part. No. 322 A.

B. S. A.

The B. S. A. Cars. Illustrated description of the two models made. 1200 w. Autocar—Oct. 31, 1908. No. 172 A.

Carburettors.

The Flow of Liquid Fuel Through Carburettor Nozzles. Robert W. A. Brewer. Reports a series of investigations made to show how it becomes an easy matter to ascertain the size of carburettor orifice to satisfy the conditions of cylinder and carburettor dimensions, and to point out some interesting problems in connection with the carburettor. Plates. 5500 w. Soc of Engrs—Nov. 2, 1908. No. 283 N.

Commercial Vehicles.

Recent Developments in Motor Vehicles for Industrial Purposes. Harry Wilkin Perry. Illustrates and describes some of the adaptations to special uses. 6000 w. Engineering Magazine—Dec., 1908. No. 671 B.

Daimler.

The 1909 Daimler Cars at Olympia. Illustrates and describes the chassis. 1000 w. Auto Jour—Nov. 14, 1908. No. 418 A.

Driving.

How to Drive a Motor Car. The first of a series of articles giving practical hints on the driving of motor vehicles. 4500 w Auto Jour—Oct. 31, 1908. Serial, 1st part. No. 173 A.

Electric Equipment.

Electric Equipment of Steam and Gasoline Automobiles. F. R. Babcock. An account of the various devices, combinations and arrangements which have been used for illumination, signalling, speed changing, etc. 3000 w. Jour W Soc of Engrs—Oct., 1908. No. 355 D.

Fire Apparatus.

New American Motor Fire Apparatus. Illustrated descriptions of extension ladder, hose wagons, etc., fitted with motors. 1200 w. Com Vehicle—Nov., 1908. No. 46 C.

Lancia.

The Lancia Petrol Cars at Olympia. Illustrated description of these Italian touring cars. 1200 w. Auto Jour—Nov 14, 1908. Serial, 1st part. No. 422 A.

The Lancia Cars. A 15-h. p. four-cylinder, and 30-h. p. six-cylinder engined chassis are described and illustrated. 1400 w. Autocar—Nov. 7, 1908. No. 300 A.

Mass.

The 1909 Mass Petrol Cars at Olympia. Illustrates and describes the interesting features of these cars. 1200 w. Auto Jour—Nov. 14, 1908. No. 420 A.

Motor Cooling.

Non-Freezing Solution for Radiators J. E. Stacey Jones. Practical tests and recommendations. 1600 w. Autocar—Nov. 14, 1908. No. 423 A.

Winter Troubles with Cooling Water. States the properties of a satisfactory cooling medium, considering the solutions at present used. 2500 w. Automobile—Nov. 19, 1908. No. 370.

Motor Rating.

The Rating of Petrol Engines. Editorial discussion of formula rating. 2000 w. Engng—Nov. 13, 1908. No. 444 A.

We supply copies of these articles. See page 747.

Motors.

The Daimler Company's New Engine. C. Y. Knight. Abstract of paper read before the Roy. Auto Club. An account of the development of the ideas and a reply to criticisms. 7500 w. Auto Jour—Oct. 24, 1908. No. 63 A.

See also Cast Iron, under MATERIALS OF CONSTRUCTION.

Napier.

The 1909 Napier Petrol Cars at Olympia. Illustrated description of the 30 h. p. 6-cylinder model. 1200 w. Auto Jour—Nov. 7, 1908. No. 297 A.

Opel.

The 40-H. P. Opel Petrol Car at Olympia. Illustrated description. 1500 w. Auto Jour—Nov. 14, 1908. No. 421 A.

Pressure Indicators.

Pressure Indicator for Motor-Car Engines. Illustrates and describes an instrument of French origin, called the "Acrometer." 600 w. Engng—Oct. 30, 1908. No. 194 A.

Shock Absorbers.

The General Utility of Shock Absorbers. Thomas J. Fay. Considers types, methods, maintenance, and cost. Ills. 2200 w. Automobile—Nov. 19, 1908. No. 369.

Siddeley.

The New Siddeleys. Describes improvements, and also a new model. Ills. 2000 w. Autocar—Oct. 24, 1908. No. 61 A.

Six-Cylinder 20-Horse-Power Siddeley Motor-Car. Illustrated detailed description of car for the Olympia exhibition. 1800 w. Engng—Nov. 6, 1908. No. 324 A.

Six-Wheeled.

Six-Wheeled Automobiles (Voitures Automobiles à Six Roues). M. Janvier. Discusses the advantages of the six-wheeled vehicle, their construction, steering, etc. Ills. 4000 w. Bul Soc d'Encour—Oct., 1908. No. 519 G.

Sizaire-Naudin.

The 12-H. P. Sizaire-Naudin Light Car at Olympia. Illustrated description of a single-cylinder, low power and low price car. 1000 w. Auto Jour—Nov. 14, 1908. Serial. 1st part. No. 419 A.

Speed Changing.

A New Speed-Changing Device for Automobiles (Nouvel Appareil de Changement progressif de Vitesse pour Automobiles). M. P. Hoffet. Illustrated description of a new Swiss device. 2000 w. Bul Tech d l Suisse Romande—Oct. 10, 1908. No. 525 D.

Speed Indicators.

See Speed, under ELECTRICAL ENGINEERING, MEASUREMENT.

Springs.

About Automobile Spring Suspensions. Thomas J. Fay. An illustrated discussion of types of springs and their action. 1500 w. Automobile—Nov. 5, 1908. Serial. 1st part. No. 117.

Tires.

How to Prolong the Life of a Tire. Hiram Percy Maxim. Thinks tires are not properly inflated. Advocates the use of a tire pressure gauge. Ills. 1300 w. Automobile—Nov. 26, 1908. No. 622.

Valveless.

The 25-H. P. Valveless Car at Olympia. Illustrated description. 700 w. Auto Jour—Nov. 7, 1908. No. 298 A.

Vinot.

The 12-16-H. P. Vinot Car. Illustrated detailed description. 1200 w. Auto Jour—Oct. 24, 1908. Serial. 1st part. No. 62 A.

White.

The 1909 White Steam Cars at Olympia. Illustrates and describes the 15 h.p. White chassis, and the Joy valve-gear. 2000 w. Auto Jour—Nov. 7, 1908. No. 299 A.

COMBUSTION MOTORS

Gas Cleaning.

See Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Engines.

100 Horse-Power Horizontal Gas Engine. Illustrated description of the latest model of a single-cylinder gas engine built by the National Gas Engine Co., Ltd. 800 w. Engr, Lond—Nov. 13, 1908. No. 454 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gasoline Engines.

The Design of Cams for High-Speed Motors. Considers the type of valve-gear most general on petrol motors. 1500 w. Mech Wld—Nov. 13, 1908. No. 429 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gas Power Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

How to Run a Suction Gas Producer. F. C. Tryon. Discusses the starting and operating of such a plant. 1800 w. Power—Nov. 17, 1908. No. 294.

Oil Engines.

Crude-Oil Engines at the Jubilee Exhibition in Prague. Describes exhibits. 4000 w. Engng—Nov. 13, 1908. No. 442 A.

Valve Gears.

Krupp's Valve Gear for Internal-Combustion Engines. Drawings and description of the valve-gear and its working. 1800 w. Mech Engr—Nov. 6, 1908. No. 306 A.

See also Gasoline Engines, under COMBUSTION MOTORS.

We supply copies of these articles. See page 747.

HEATING AND COOLING.

Central Plants.

Central Heating Plants (Fernheizwerke). Max Hottinger. Discusses the various systems and the design of plants. Ills. Serial. 1st part. 1800 w. Schweiz Bau—Oct. 3, 1908. No. 560 B.

Drying Plants.

Calculation of Air and Heat Requirements of Drying Plants (Die Berechnung des Luft- und Wärmebedarfs für Trockenanlagen in der Praxis). W. Franken. Gives a number of very elaborate tables. 8700 w. Gesundheits-Ing—Oct. 24, 1908. No. 588 D.

Gas Heating.

The Use of Coal Gas in Baking Ovens. Information on various applications of gas firing. 2000 w. Prac Engr—Nov. 6, 1908. No. 301 A.

Modern Methods of Heating. H. R. Basford. Read before the Pacific Coast Gas Assn. Gives a report of automatic gas water heating devices and their performances. Discussion. 4400 w. Pro Age—Nov. 16, 1908. No. 290.

Hot-Water Heating.

The Design of Low-Pressure Hot-Water Heating Systems (Calcul des Installations de Chauffage par l'Eau Chaude à Basse Pression). E. Mathieu. A mathematical discussion. Ills. Serial. 1st part. 1000 w. La Métal—Oct. 14, 1908. No. 531 D.

Pipe Bending.

How to Make Hardwood Forms for Bending Iron Pipe Cold. Illustrates and describes types and their making. 1200 w. Dom Engng—Nov. 7, 1908. No. 159.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Test of Four 35,000,000-Gal. Centrifugal Pumping Units at Pittsburg. Gives extracts from a report showing the results of duty tests. 1200 w. Eng News—Nov. 26, 1908. No. 637.

The Compounding of Centrifugal Pumps (Ueber die Schaltung von Schleuderpumpen). A. Laponche. A mathematical discussion of the two cases of compounding for pressure or for capacity. Ills. 3200 w. Die Turbine—Oct. 20, 1908. No. 567 D.

See also Fire Boats, under MARINE AND NAVAL ENGINEERING.

Penstocks.

A Diagram for Calculating Penstocks. Richard Muller. Gives diagram for calculating steel pipes of large size, with explanation of its use. 1600 w. Eng Rec—Nov. 14, 1908. No. 252.

Pipe Flow.

Flow of Water in Pipes and Flumes. Franklin Van Winkle. Discusses drop in pressure due to friction, giving charts for determining the size of pipe for a given flow. Ills. 4000 w. Power—Nov. 10, 1908. No. 162.

Pumping Engines.

New Pumping Engines for the Metropolitan Water Board. Illustrated description of the engines at Kempton Park Station. 2000 w. Engr, Lond—Oct. 23, 1908. No. 80 A.

Riveting Machines.

Some Notes on Hydraulic Plate Cutting and Riveting Machines. Norman S. Trustrum. Read before the Jun. Inst. of Engrs. Discusses materials, methods and related matters. Ills. 2000 w. Prac Engr—Nov. 13, 1908. Serial. 1st part. No. 427 A.

Turbines.

Oscillations in Pipe Lines and Their Influence on the Operation of Turbines (Schwingungen in Flüssigkeitsleitungen und ihr Einfluss auf den Gang von Kreiselrädern). H. Lorenz. Mathematical. Ills. Serial. 1st part. 3500 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 10, 1908. No. 564 D.

MACHINE ELEMENTS AND DESIGN.

Clutches.

Clutches. Discussion of paper by Henry Souther. 2000 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 646 F.

Crushers.

Balancing a Rock Crusher—A Peculiar Problem. O. P. Hood. Presents the method of determining the unbalanced forces by graphical solution, and of reducing the vibration. 2500 w. Am Mach—Vol. 31. No. 48. No. 626.

Cylinders.

Distortions Symmetrical About the Axes of Thin-Walled Cylinders (Achsensymmetrische Verzerrungen in dünnwandigen Hohlzylindern). Rudolf Lorenz. Mathematical. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 604 D.

Drafting.

Present Practice in Drafting-Room Conventions. John S Reid. Summary of answers to questions on methods. 3000 w. Am Mach—Vol. 31. No. 47. No. 362.

Gears.

Interchangeable Involute Gear Tooth Systems. Ralph E. Flanders. Discusses the effect of varying the pressure angle and addendum. 4500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 654 F.

Spur Gearing on Heavy Railway Motor Equipments. Norman Litchfield. Gives facts gathered in a study of this subject. Ills. 1600 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 655 F.

Graphical Charts.

Isometric Plotting of Graphical Charts. Guido H. Marx. Explains the principle

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of isometric projection, illustrating by example. 1500 w. Am Mach—Vol. 31. No. 46. No. 220.

Joints.

A Note on Ball-and-Socket Joints. An investigation of the limiting proportions of such joints. 600 w. Engr, Lond—Nov. 13, 1908. No. 453 A.

Journals.

Friction and Bearing Pressures of Journals. W. H. Scott. A review of theories and experiments. 2500 w. Mech Wld—Oct. 23, 1908. No. 68 A.

Reducing Wheels.

The Practical Operation of Reducing Wheels. Hubert E. Collins. Illustrated explanation of parts of certain makes of wheel, with instructions for handling, etc. 2000 w. Power—Nov. 10, 1908. No. 161.

Screw Jacks.

The Design of a 20-Ton Screw Jack. Drawings and Calculations. 500 w. Prac Engr—Oct. 30, 1908. No. 180 A.

Stresses.

Stress Disturbance by Grooves (Ueber die Spannungsstörungen durch Kerben und Tellen und über die Spannungsverteilung in Verbundkörpern). Alfons Leon. A mathematical paper on the effects on stress distribution of various types of grooves. Ills. Serial. 1st part. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 24, 1908. No. 578 D.

MACHINE WORKS AND FOUNDRIES.

Blacksmith Shops.

Tools for Increasing Production in Blacksmith Shops. James Cran. Illustrates and describes various useful appliances. 2000 w. Mach., N Y—Nov., 1908. No. 35 C.

Boring Machines.

A Large, Vertical, Cylinder Boring Machine. Philip Bellows. Describes a special design, equipped with friction drive. Ills. 3000 w. Am Mach—Vol. 31. No. 46. No. 219.

Brazing.

Brazing Cast Iron and Other Metals. F. N. Blake. Practical notes. 800 w. Prac Engr—Oct. 23, 1908. No. 66 A.

Castings.

Elementary Notes on Iron with a Few Side Lights on Malleable Castings. C. A. Swallow. 2000 w. Foundry—Nov., 1908. No. 59.

Casting Printing Press Cylinders. A. Manchester. Shows the manner of molding and casting. Ills. 1200 w. Am Mach—Vol. 31. No. 47. No. 363.

Figuring the Weight of Cast Steel. R. A. Bull. Explains a method of finding the weight of steel castings. 1200 w. Foundry—Nov., 1903. No. 56.

See also Cast Iron, under MATERIALS OF CONSTRUCTION.

Core Making.

Striking Up Cores in Loam. Walter J. May. Describes methods. Ills. 1000 w. Prac Engr—Oct. 23, 1908. No. 65 A.

Cores.

Method of Ascertaining the Lifting Pressure of Molten Metal on Cores. F. Webster. Experimental study. Ills. 1200 w. Foundry—Nov., 1908. No. 54.

Cupolas.

The Design of Cupolas (Die Berechnung der Kupolofenabmessungen). Bernhard Osann. Discusses principally air heating and the heating of the fore-hearth. Ills. Serial. 1st part. 4500 w. Stahl u Eisen—Oct. 7, 1908. No. 543 D.

Drilling.

Comparisons of Carbon and High-Speed Drills. Reports tests which show that the high-speed drills drilled 57 times as many holes as the carbon drills under the same conditions. 1800 w. Am Mach—Vol. 31. No. 46. No. 222.

Foundry Appliances.

The Improvements in Foundry Tools and Appliances. James F. Hobart. Reviews some of the improvements in tools and methods. 2200 w. Mech Wld—Nov. 6, 1908. No. 304 A.

Foundry Management.

See Accounting, and Management, under INDUSTRIAL ECONOMY.

Foundry Practice.

Method of Obtaining a Uniform Chill in Cast Iron Rolls. Thomas D. West. Read before the Am. Soc. for Test. Mat. Illustrates and describes devices used. 1200 w. Foundry—Nov., 1908. No. 57.

Chemical Analysis in Relation to Foundry Practice. The present number briefly considers oils, fuel, and water. 1200 w. Prac Engr—Oct. 23, 1908. Serial. 1st part. No. 67 A.

See also Castings, Molding Machines, Patterns, and Sand Blast, under MACHINE WORKS AND FOUNDRIES.

Furnaces.

Industrial Uses of Gas. Abstract of a paper by E. C. Riley, on applications made by the Great Western Ry. Co. at Swindon, England. Ills. 2000 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 455 A.

Galvanizing.

Modern Methods of Galvanizing. Illustrates and describes the electrolytic and sherardizing processes. 1000 w. Ir & Coal Trds Rev—Oct. 30, 1908. No. 203 A.

Gear Cutting.

An English Universal Gear Cutting Machine. Joseph Horner. Illustrated description of a 54-in. machine that cuts spurs and spirals with a hob or circular cutter and worm wheels with a taper hob or fly cutter. 2500 w. Am Mach—Vol. 31. No. 47. No. 361.

We supply copies of these articles. See page 747.

Grinding.

Grinding Threading Chasers for Brass Work. Ethan Viall. An illustrated article describing methods. 1500 w. Mach, N Y —Nov., 1908. No. 36 C.

Hydraulic Machines.

See Riveting Machines, under HYDRAULIC MACHINERY.

Lathes.

Improvements in Multiple Spindle Lathes and Like Machines. Illustrates and describes an invention patented by George Mellis for intermittently rotating the turret head, for stopping its rotation and locking it in various positions. 1500 w. Prac Engr—Nov 13, 1908. No. 428 A.

Machine Tools.

Some French Machine-Tools at the Franco-British Exhibition. Describes interesting examples of French practice. Ills. 1500 w. Engng—Oct. 30, 1908. Serial. 1st part. No. 190 A.

Milling.

Setting-Angles for Milling Angular Cutters and Taper Reamers. W. A. Knight. Diagrams and directions for calculations, with tables, and examples. 4000 w. Mach, N Y—Nov., 1908. No. 33 C.

Milling Cutters.

The Development of a High Speed Milling Cutter, with Inserted Blades for High Powered Milling Machines. Wilfred Lewis and William H. Taylor. Describes the cutter, discussing points considered in its construction, reporting tests. Ills. 2200 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 656 F.

Milling Machines.

Accurate Index Wheels and Milling Operations. Illustrated description of special machines for milling channels in type setter cylinders. 1500 w. Am Mach —Vol. 31. No. 45. No. 122.

Efficiency Tests of Milling Machines and Milling Cutters. A. L. De Leeuw. Deals with the efficiency problem only, showing results obtained rather than the means by which they were obtained. Ills. 6000 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 641 F.

Molding Machines.

A Difficult Molding Machine Job. Illustrates and describes the making of an automobile crank case mold. 1200 w. Foundry—Nov., 1908. No. 50.

Machine Molding for Large Castings. C. S. Bonsall. Read before the Nat. Found. Assn. Illustrated account of experience of an engine works. 2000 w. Ir Age—Nov. 26, 1908. No. 496.

Patterns.

Rapping Plates—A Discussion of the Proper Use and Abuse of Patterns. C. Neill. Ills. 2200 w. Foundry. Nov., 1908. No. 52.

Punching Machines.

Punching Machines (Ueber Durchstossmaschinen). E. Kühne. Discusses their design, operation, etc. Ills. 2700 w. Zeitschr f Werkzeug—Oct. 5, 1908. No. 569 D.

Sand Blast.

The Sand Blast in the Foundry. James M. Betton. The first of the series of articles on the use of the sand blast for cleaning castings. 2500 w. Foundry—Nov., 1908. Serial. 1st part. No. 53.

Shop Hygiene.

A Simple Method for the Detection of Gaseous Impurities in the Air of Factories (Vereinfachte Methoden zur Bestimmung der gasförmigen Verunreinigungen in der Fabrikluft). Martin Hahn. 4000 w. Gesundheits-Ing—Oct. 31, 1908. No. 589 D.

Shop Management.

See Management, under INDUSTRIAL ECONOMY.

Shop Photography.

Industrial Photography. S. Ashton Hand. An illustrated paper dealing with apparatus, preparation, focusing, copying, enlarging, etc. 3000 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 642 F.

Shop Practice.

Ways and Means of Producing Work in the Machine Shop. W. Burns. A summary of shop conditions contributing to efficiency with suggestions for improvements. 2000 w. Engineering Magazine—Dec., 1908. No. 675 B.

Making Pliers of Various Kinds and Sizes. Illustrates and describes novel methods and details of a new shop at Utica, N. Y. 2200 w. Am Mach—Vol. 31. No. 48. No. 627.

Machining the Casting for a Plain Milling Machine Column. B. R. Ashe. Prize paper. Illustrated description of the work. 1500 w. Mech Wld—Oct. 30, 1908. No. 179 A.

Shops.

The Windsor Machine Co.—Examples of Its Shop Practice. Illustrated description of these shops and selected operations. 3500 w. Mach, N Y—Nov., 1908. No. 34 C.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Straightening Presses.

Spindle Straightening Presses (Ueber Spindelrichtpressen). E. Kühne. A mathematical discussion. Ills. 2000 w. Zeitschr f Werkzeug—Oct. 5, 1908. No. 570 D.

Tempering.

Methods of Hardening Steel. E. R. Markham. Discusses methods best for various kinds of work. 2000 w. Mech Wld—Nov. 6, 1908. No. 305 A.

We supply copies of these articles. See page 747.

Tinning.

The Method of Tinning Cast-Iron. Illustrated description. 2500 w. Brass Wld—Nov., 1908. No. 479.

Tool Making.

Methods of Making Form Tools and Cutters. E. M. King. Diagrams and description of methods used. 1000 w. Am Mach—Vol. 31. No. 47. No. 360.

Tube Making.

Plant Used in the Manufacture of Tubes. W. H. A. Robertson. Read before the Inst. of Metals. Describes the more general methods of manufacture. 3000 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 458 A.

The Manufacture of Seamless Steel Tubing. From a lecture by George Lees. Illustrates and describes the processes of drawing tubes from solid steel billets and plates. 4000 w. Ir Trd Rev—Nov. 19, 1908. No. 364.

Welding.

Autogenous Welding by the Oxy-Acetylene Flame. Eugene Bournonville. Read before the Tech. Club of Syracuse, N. Y. Brief review of the process, describing the types of torches used. 1000 w. Ir Age—Nov. 26, 1908. No. 495.

Portable Oxy-Acetylene Welding Outfit. E. F. Lake. Illustrated description of the apparatus and its work. 1800 w. Am Mach—Vol. 31. No. 45. No. 124.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Commercial Use of Vanadium. T. F. V. Curran. Information concerning its use and the results secured. 1500 w. Ir Trd Rev—Nov. 19, 1908. No. 365.

Vanadium and Its Estimation. George Auchy. Discusses whether or not vanadium is all that is claimed, the tests needed, and related matters. 3000 w. Ir Age—Nov. 12, 1908. No. 215.

Aluminium.

See same title, under MINING AND METALLURGY, MINOR MINERALS.

Bronze.

Notes on Phosphor Bronze. A. Philip. Read before the Inst. of Metals. A record of results of tests to obtain information in regard to chemical specification for this material. Also effect of treatment, etc. 3500 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 457 A.

Cast Iron.

Composition of Automobile Cylinders. Harry B. de Pont. Gives experience with various grades of iron. 2500 w. Foundry—Nov., 1908. No. 51.

Carbon and the Properties of Cast Iron. Henry M. Howe. The difference in the properties is considered to be due to the distribution of its carbon between the graphitic and combined states. 4000 w. Eng & Min Jour—Nov. 14, 1908. No. 256.

Cast Steel.

See Castings, under MACHINE WORKS AND FOUNDRIES.

Corrosion.

See same title, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Metallography.

Metallographs, or Photographs of the Structure of Metal Specimens. J. F. Springer. An illustrated explanation of their value in the study of metals. 1700 w. Sci Am—Nov. 7, 1908. No. 106.

Alumina for Polishing (Alumine de Polisage). M. Robin. Discusses materials for polishing specimens for metallographic study. Ills. 2000 w. Rev de Métal—Oct., 1908. No. 514 E + F.

Researches on Tempering and Annealing Iron and Steel (Recherches sur la Trempe et le Revenu du Fer et de l'Acier). Ed. Maurer. An extensive study of changes in physical, chemical and metallographic properties in the heat treatment of iron and steel. Ills. 11000 w. Rev de Métal—Oct., 1908. No. 513 E + F.

A Contribution to the Metallographic Study of Tempered Steels (Contribution à l'Étude Métallographique des Aciers Trempés). M. Kourbatoff. Discusses the transformations of austenite and troostite. Ills. 2000 w. Rev de Métal—Oct., 1908. No. 512 E + F.

See also Testing Methods, under MEASUREMENT.

Steel.

Benefits Derived by Heat-Treating Steel. Thomas J. Fay. Aims to explain methods by which good steel may be fashioned into shape and then rendered hard or soft, ductile or dynamic, as the service may demand. 3300 w. Automobile—Nov. 26, 1908. Serial. 1st part. No. 621.

MEASUREMENT.

Brakes.

Prony Brakes for Practical Testing. G. Everett Quick. Illustrates and describes different forms of friction brakes and their application and operation. 3000 w. Power—Nov. 17, 1908. No. 291.

Hardness.

A Simplified Ball-Test Device and the Results Obtained (Vorrichtung zur vereinfachten Prüfung der Kugeldruckhärte und die damit erzielten Ergebnisse). A. Martens and E. Heyn. Illustrated description. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 606 D.

See also Testing Methods, under MEASUREMENT.

Pressure.

See Pressure Indicators, under AUTOMOBILES.

Testing Methods.

Corrosion Tests of Iron and Steel (Essais des Fers et des Aciers par Corro-

sion). Ch. Frémont. An exhaustive discussion of the value of etching with various chemical reagents in the study and testing of iron and steel. Ills. 7000 w. Rev de Métal—Oct., 1908. No. 511 E + F.

The Ball Hardness Test as a Measure of the Strength of Materials (Die Kugeldruckhärte als Mass der Zerreissfestigkeit). Alfred Kurth. Mathematical. Ills. 2800 w. Zeitschr d Ver Deutscher Ing—Oct. 3, 1908. No. 599 D.

Thermometry.

Some New Measurements with the Gas Thermometer. Arthur L. Day and J. K. Clement. A study, giving detailed description of apparatus used, methods and results. Ills. 15800 w. Am Jour of Sci—Nov., 1908. No. 206 D.

Weight.

The Merrick Conveyor Weightometer. Detailed description of this appliance for weighing coal or other material while traveling in a continuous stream along the belt of a conveyor. Ills. 2500 w. Engng—Oct. 30, 1908. No. 192 A.

POWER AND TRANSMISSION.

Air Compressors.

A Complete Line of German Air Compressors. Newhaus W. Czenaison. Illustrates and describes types of the Borsig compressors. 2000 w. Am Mach—Vol. 31. No. 45. No. 123.

Operating Steam Driven Air Compressors. C. A. Dawley. Calls attention to points the engineer should understand. 2500 w. Power—Nov. 24, 1908. No. 471.

Controlling the Output of the Air Compressor. Frank Richards. Concerning a device for automatically varying the output of an air compressor. Ills. 2000 w. Eng News—Nov. 5, 1908. No. 100.

Notable Performances of Air Compressors (Bemerkungswerte Ausführungen von Luftkompressoren). Hans Wunderlich. Describes machines by various European makers and gives indicator cards. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Oct. 31, 1908. No. 607 D.

Belts.

Power Transmission by Endless Belts. W. Worby Beaumont. Discusses the efficiency of belts and the importance of high frictional adhesion. 1700 w. Elec Rev, Lond—Oct. 30, 1908. No. 183 A.

Electric Driving.

The Economy of the Individual Motor Drive for Machine Tools. Howard S. Knowlton. An illustrated article favoring individual rather than group driving and stating its advantages. 3500 w. Engineering Magazine—Dec., 1908. No. 670 B.

Electric Power.

See Industrial Plants, under ELECTRICAL ENGINEERING, DISTRIBUTION.

Gas Power.

Suction Gas Producer Power for Factories. L. P. Tolman. Claims that it saves from 1-2 to 3-4 of the coal required for steam power. Ills. 2000 w. Am Mach—Vol. 31. No. 45. No. 125.

Gearing.

See Gears, under MACHINE ELEMENTS AND DESIGN.

Lubricants.

Filtering Oil for Repeated Use. John M. Howland. Illustrated description of the Turner filter and its operation. 800 w. Power—Nov. 10, 1908. No. 164.

Lubrication.

The Lubrication of Bearings. A. L. Campbell. Briefly considers classes of lubricants, their quality, and the manner of applying to bearings. Ills. 3000 w. Engineering Magazine—Dec., 1908. No. 678 B.

Power Plants.

Power Plant of the New Plaza Hotel, New York. Plans and detailed description of a mechanical equipment of unusual size. 5000 w. Eng Rec—Nov. 21, 1908. No. 412.

See also Coal Bunkers, under CIVIL ENGINEERING, CONSTRUCTION.

STEAM ENGINEERING.

Boiler Design.

Influence of Strap on Lap Boiler Seams. S. F. Jeter. Government tests show that strap must always add some strength to the joint. 2000 w. Power—Nov. 24, 1908. No. 469.

Boiler Draft.

Forced Draft for Steam Boilers. W. H. Wakeman. An illustrated article describing the advantages and disadvantages of forced draft, and suggestions relating to its use. 2000 w. Elec Wld—Nov. 7, 1908. Serial. 1st part. No 97.

Boiler Furnaces.

Principles of Furnace Design for Smokeless Combustion. C. H. McClure. Read before the Am. Chem. Soc. States the requirements of smokeless furnaces, discussing each. 2500 w. Eng Rec—Nov. 7, 1908. No. 142.

Boiler Inspection.

The Inspection of Steam Boilers. James F. Hobart. Remarks on necessary tools and clothes for the purpose, giving a list of questions, and practical instruction. 4500 w. Power—Nov. 24, 1908. No. 468.

Boilers.

New Developments in Boilers and Accessories (Neuerungen auf dem Gebiet des Dampfkesselwesens). Ernst Arnold. Illustrates and describes recent European types of boilers, superheaters, economizers, etc. Serial. 1st part 3300 w. Stahl u Eisen—Oct. 7, 1908. No. 544 D.

Boiler Scale.

Concerning Solid Deposits in Steam Boilers. Deals principally with scale formed from dissolved matter that can-

not be removed by filtration. Ills. 13000 w. Locomotive—Oct., 1908. No. 493.

Boiler Waters.

Effect of Oil in Steam Boilers. J. E. Terman. Describes bags caused by oil, and matters relating to the subject. 1600 w. Power—Nov. 3, 1908. No. 43.

See also Feed-Water Heating, under STEAM ENGINEERING; Analysis, under CIVIL ENGINEERING, WATER SUPPLY; and Rand, under MINING AND METALLURGY, GOLD AND SILVER.

Condensers.

Condensers. S. K. Patterson. Considers the general theory of condensers, types, difficulties in design and operation, and related matters. 2500 w. Elec Rev, N Y—Nov. 28, 1908. No. 499.

See also same title, under MARINE AND NAVAL ENGINEERING.

Engine Efficiency.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engines.

Design of an English High-Speed Steam Engine. Philip Bellows. Discusses an engine of the semi-superposed type, calling attention to noteworthy features. Ills. 4500 w. Power—Nov. 3, 1908. No. 42.

Engine Tests.

Tests on a Wolf Superheated Steam Portable Engine (Versuche mit einer Heissdampf-lokomobile von R. Wolf). Herrn Gutermuth und Watzinger. Reports tests on a 100-140 horse power tandem engine. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 3, 1908. No. 598 D.

Entropy.

The Entropy Diagram and Its Application to Steam (Die Entropiefunktion und ihre Anwendung auf Wasserdampf). J. W. Haeussler. Refers particularly to the thermo-dynamics of the steam turbine. Serial. 1st part. 2000 w. Die Turbine—Oct. 20, 1908. No. 568 D.

Feed-Water Heating.

Means and Methods for Heating the Feed Water of Steam Boilers. Reginald Pelham Bolton. First of a series of three articles examining the economy of feed-water heating. Ills. 3000 w. Engineering Magazine—Dec., 1908. No. 672 B.

Fuels.

Fuel Economy Tests at a Large Oil Burning Electric Power Plant Having Steam Engine Prime Movers. C. R. Weymouth. Presents results of fuel economy tests at the Redondo Plant, near Los Angeles, Cal. 6500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 653 F.

Heat Storage.

Heat Accumulation in Steam Engineering. L. A. Battu. Briefly reviews the development of thermal storage plants, describing special apparatus and explaining when it can be made useful. Ills. Also discussion. 10500 w. Pro N Y R R Club—Oct. 16, 1908. No. 205.

Oil Fuel.

See Fuels, under STEAM ENGINEERING; and Oil Fuel, under MARINE AND NAVAL ENGINEERING.

Steam Pipes.

See Pipe Bending, under HEATING AND COOLING.

Steam Properties.

The Total Heat of Saturated Steam. Dr. Harvey N. Davis. Proposes a new formula for the range from 212 to 400 deg. the accuracy of which is believed to be within about 0.1 per cent. 3500 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 644 F.

See also Superheated Steam, under STEAM ENGINEERING.

Stoking.

Firing Cheap Grades of Fuel. William Kavanagh. Briefly outlines methods of firing that will avoid smoke. 1000 w. Power—Nov. 17, 1908. No. 296.

The Training of Firemen in Central Stations (L'Education Professionnelle du Personnel Chauffeur dans les Stations Centrales). J. Izart. Discusses the essentials of good boiler firing and means of obtaining it. Ills. 3500 w. L'Elecn—Oct. 17, 1908. No. 529 D.

Superheated Steam.

Thermal Properties of Superheated Steam. Discussion of the paper by Prof. R. C. H. Heck. 1400 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 645 F.

See Engine Tests, under STEAM ENGINEERING.

Turbine Design.

The Design of Steam Turbines (Sul "Calcolo" delle Turbine a Vapore). G. B. Dall'Armi. A mathematical demonstration of the method employed. Ills. 7000 w. Riv Marit—Oct., 1908. No. 538 E + F.

Turbines.

The Development of the Small Steam Turbine. Charles A. Howard. Illustrates and describes features of design and construction of leading types of small capacity turbines used in the United States. 2500 w. Engineering Magazine—Dec., 1908. No. 673 B.

The Low Pressure Steam Turbine. Charles B. Burleigh. Abstract of a paper read before the Nat. Assn. of Cotton Mfrs. Discusses the uses to which it may be applied with advantage. 2500 w. Power—Nov. 17, 1908. No. 295.

The Curtis Horizontal Steam Turbine. H. E. Twombly. Directions for operating this type. Ills. 2500 w. Power—Nov. 10, 1908. No. 165.

Running a Parsons Turbine. H. M. MacSweeney. Suggestions for operation. 2000 w. Power—Nov. 24, 1908. No. 470.

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The New Eyermann Steam Turbine. Dr. Alfred Gradenwitz. Illustrated description of a turbine showing decided departures from usual practice. 2500 w. Power—Nov. 24, 1908. No. 467.

The Attachment of Steam-Turbine Blades (Ueber die Befestigung von Dampfturbinen-schaufeln). Wilhelm Gentsch. Illustrated description of the practice of various makers. Serial. 1st part. 2000 w. Die Turbine—Oct. 5, 1908. No. 566 D.

The Turbine with Regenerator as a Heat Motor (Die Turbine mit Regenerator als Wärmemotor). J. Nadrowski. A study of the thermodynamics of the steam turbine. Ills. Serial. 1st part. 2800 w. Die Turbine—Oct. 5, 1908. No. 565 D.

See also Entropy, under STEAM ENGINEERING.

TRANSPORTING AND CONVEYING.

Cableways.

Short-Distance Transportation. Frank C. Perkins. Illustrated description of a modern freight conveying system. 1000 w. Sci Am Sup—Nov. 21, 1908. No. 334.

Coal Handling.

Storage Yard and Mechanical Handling and Loading Plant at the Rheinelbe III Mine (Lagerplatz und Vorrichtung zum mechanischen Stürzen und Rückladen von Kohlen auf der Schachtanlage Rheinelbe III). Wilhelm Schulte. Illustrated description. 3100 w. Glückauf—Oct. 17, 1908. No. 555 D.

See also Weight, under MEASUREMENT.

Conveyors.

The Use and Performance of Belt Conveyors. Werner Boecklin. A useful summary of general working principles tending to economical operation. Ills. 2500 w. Engineering Magazine—Dec., 1908. No. 676 B.

A Novel Belt Conveyor System. Illustrated description of the system used in concrete construction on the New York Barge Canal. 2000 w. Ir Age—Nov. 5, 1908. No. 86.

Recent Developments in Material Handling Devices (Ueber einige Neuerungen im Massentransport). M. Buhle. Describes recent European types of conveyors, bucket elevators, etc. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 23, 1908. No. 582 D.

See also Weight, under MEASUREMENT.

Cranes.

Modern Handling Cranes Built by Adolf Bleichert & Co, Leipzig (Moderne Verladekrane gebaut von Adolf Bleichert & Co. in Leipzig-Gohlis). Georg von Hanffstengel. Illustrated description. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—Oct. 31, 1908. No. 608 D.

See also Floating Cranes, and Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Transporter Bridges.

The Old Bizerte Transporter Bridge at the Brest Arsenal (Transport de l'Ancien Pont à Transbordeur de Bizerte dans l'Arsenal Maritime de Brest). G. Leinekugel Le Cocq. Illustrated description. 3500 w. Génie Civil—Oct. 31, 1908. No. 536 D.

Traveling Bridges.

A Large Material Handling Plant. Brief illustrated description of the use of traveling bridges in building a river lock. 1000 w. Ir Age—Nov. 19, 1908. No. 336.

MISCELLANY.

Aeronautics.

Longitudinal Stability of Aeroplanes. Henry T. Strong. Explains a method of keeping the line of thrust of propellers always horizontal. 1500 w. Sci Am Sup—Nov. 7, 1908. No. 107.

The Lift and Drift of Arched Surfaces. Matthew Bacon Sellers. A study of their behavior in a uniform current of air. 2500 w. Sci Am Sup—Nov. 14, 1908. No. 245.

The Laws of Flight. F. W. Lanchester. Read before the British Assn., at Dublin. Considers information obtained by observation and experiment, explaining the theory of flight developed by the author. 3000 w. Engr, Lond—Sept. 18, 1908. Serial. 1st part. No. 95414 A.

The Problem of Aerial Navigation. B. Baden-Powell. A reply to Prof. Simon Newcomb's paper in the September issue of the same magazine. 4000 w. Nineteenth Cent—Nov., 1908. No. 289 D.

Battles in the Sky. Major Goebel. Trans. from *Illus. Zeit.* Discusses the military utility of the airship. 2000 w. Sci Am Sup—Nov. 14, 1908. No. 246.

Progress in Aviation. G. H. Bryan. A review of progress. Ills. 4000 w. Nature—Oct. 29, 1908. No. 166 A.

Cross-Country the Aeroplane Now Travels. W. F. Bradley. Illustrated account of recent achievements. 1500 w. Automobile—Nov. 19, 1908. No. 371.

An Aeroplane Factory. Jacques Boyer. Illustrated description of the Vorsin factory at Billancourt, France. 900 w. Sci Am—Nov. 21, 1908. No. 333.

Carbonic Acid.

The Physical Properties of Carbonic Acid and the Conditions of Its Economic Storage for Transportation. Prof. T. Stewart. Gives tables and charts showing the physical properties, results of the author's experiments on commercial carbonic acid in steel cylinders, and a method of designing commercial carbonic acid cylinders. 13500 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 643 F.

Gyroscopes.

Recent Development in Gyroscope Design. Describes a new form for engineering use invented by Prof. Narciss Ach. 3000 w. Sci Am Sup—Nov. 21, 1908. No. 335.

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MINING AND METALLURGY

COAL AND COKE.

Coke Ovens.

Levellers for Coke Ovens. A. Thau, in Glückauf. Illustrates and describes types of mechanical levellers. 1000 w. Col Guard—Nov. 6, 1908. No. 317 A.

Electric Power.

Development of Electric Power in Coal Mines. George E. Walsh. Remarks on the Applications, recent installations, etc. 2000 w. Eng & Min Jour—Nov. 21, 1908. No. 410.

Explosions.

The Prevention of Mine Explosions. Recommendations of a committee appointed to investigate coal mine explosions. 2500 w. Can Min Jour—Nov. 15, 1908. No. 464.

Norton Hill Colliery Explosion. Report by Joseph S. Martin, on the circumstances attending the explosion of April 9, 1908. 3500 w. Col Guard—Oct. 30, 1908. No. 187 A.

See also Mine Dust, under COAL AND COKE.

Explosives.

Safety Blasting Explosives. Arthur M. Carney. Discusses the classes and properties of different explosives, and the apparatus and methods used in testing. Ills. 3500 w. Mines & Min—Nov., 1908. No. 30 C.

Tests with Compressed Gunpowder, Nitroglycerin and Ammonium Nitrate Explosives in the Schwalbach Mine (Versuche mit komprimiertem Pulver, Nitroglyzerin- und Ammonsalpeter-Sprengstoffen im Schwalbach Flöz der Königl. Steinkohlengrube Schwalbach-Saar). Erich Seidl. Describes the tests and gives the results and conclusions drawn from them. Ills. 3100 w. Glückauf—Oct. 31, 1908. No. 558 D.

Handling.

See Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Illinois.

Studies of Illinois Coals. Gives results of investigations made by experts, with discussions of certain phases, with summary and conclusions. 22500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 688 E.

Mine Dust.

The Present Position of the Coal Dust Problem. James and John Ashworth. Read before the Can. Min. Inst. Discusses coal dust as connected with colliery explosions. 2000 w. Can Min Jour—Nov. 1, 1908. No. 45.

Mine Gas.

The Influence of Atmospheric Conditions on the Amount of Water and Gas in Mines (Der Einfluss der Luftdruckschwankungen auf den Wasserdrang und den Gasaustritt in Bergwerken). Chr. Mezger. A discussion based on extensive observations. Ills. Serial. 1st part. 5600 w. Glückauf—Oct. 24, 1908. No. 557 D.

Mining.

The Cost of Longwall in England. George R. Dixon. Gives details and dimensions of the system. 2000 w. Eng & Min Jour—Nov. 14, 1908. No. 260.

Advanced Methods of Mining Coal in Silesia. Lucius W. Mayer. Illustrates and describes a system in which filling is flushed into the workings and total extraction accomplished. 6000 w. Eng & Min Jour—Nov. 7, 1908. No. 145.

The Determination of the Net Contents of Loaded Cars (Die Ermittlung des Nettoinhaltes beladener Förderwagen). A. Weise. Describes methods for the purposes of miners' wage determination. Ills. 2500 w. Glückauf—Oct. 3, 1908. No. 553 D.

See also Eight-Hour Day, under INDUSTRIAL ECONOMY.

Mining Plants.

Re-Sinking and Re-Equipping the Great Western Colliery Company's Maritime Pit. Hugh Bramwell. Read before the S. Wales Inst. of Engrs. Illustrates and describes the work and methods. 5000 w. Ir & Coal Trds Rev—Oct. 23, 1908. No 81 A.

Storage.

See Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Washing.

Coal-Washing Jigs. E. J. Munby. Describes the Foust jig and its trial. Ills. 1500 w. Sci Am Sup—Nov. 14, 1908. No. 247.

COPPER.

Australia.

See same title, under GOLD AND SILVER.

Austria.

The Value of the Schneeberg Deposits (Die Bauwürdigkeit der Schneeberger Lagerstätten). B. Granigg. A discussion of the economy of further working of these zinc-lead-copper deposits in the Austrian Tyrol. Ills. Serial. 1st part. 4500 w. Oest Zeitschr f Berg u Hüttenwesen—Oct. 24, 1908. No. 551 D.

Electro-Metallurgy.

Improvements in the Construction and

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Manufacture of Parabolic Reflectors. Sherard Cowper-Coles. Describes an electrolytic process for making metallic reflectors. Ills. 4500 w. Engrg—Oct. 23, 1908. No. 78 A.

Idaho.

Snowstorm Copper Deposits. Abstract of Paper 62, U. S. Geol. Survey, by F. L. Ransome and F. C. Calkins. Describes the deposits of this productive mine in Idaho. 1000 w. Min & Sci Pr—Nov. 21, 1908. No. 623.

Mattes.

The Constitution of Copper-Iron and Copper-Lead-Iron Mattes. Charles H. Fulton and Ivan E. Goodner. Determines, by metallographic and chemical means, the constitution of the mattes named. Ills. 8500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 685 C.

Peru.

The Mineral Resources of the Department of Apurimac, Peru. A. Jochamowitz. Reports of various districts, where copper, silver and gold are found. 4500 w. Min Jour—Nov. 7, 1908. No. 321 A.

See also Smelting, under COPPER.

Reverberatory Furnaces.

Regenerative Reverberatory Copper Furnace. Fred A. Leas. Plans and description of an oil-burning furnace at the works of the Peyton Chemical Company. 2000 w. Eng & Min Jour—Nov. 7, 1908. No. 147.

Smelters.

Construction of 100-Ton Copper Smelting Plant. Charles C. Christensen. Illustrates and describes some of the essential features. 2000 w. Eng & Min Jour—Oct. 31, 1908. No. 16.

Smelting.

Salt Lake, Utah. A letter from Mr. Courtenay DeKalb, describing a recent invention for condensing smelter fume. 1100 w. Min & Sci Pr—Nov. 14, 1908. No. 359.

Smelting at Cerro de Pasco, Peru. Lester W. Strauss. Illustrates and describes the plant and methods used for these copper ores. 5800 w. Min & Sci Pr—Nov. 7, 1908. No. 382.

GOLD AND SILVER.

Alabama.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Australia.

Cobar Gold and Copper Field, New South Wales. Gerard W. Williams. Oxidized gold ores at surface become refractory and copper-bearing with depth, presenting difficulties in treatment. Ills. 1200 w. Eng & Min Jour—Nov. 14, 1908. No. 259.

Bohemia.

The Silver Lead Mines of Przibram. H. L. Terry. Descriptive account of mines famous for their great depth, and where the galena has proved increasingly argentiferous with depth. 3000 w. Min Jour—Nov. 7, 1908. No. 320 A.

California.

The Eagle Shawmut Mine. S. E. Montgomery. A discussion of present day methods of mining low-grade ores. 2000 w. Cal Jour of Tech—Oct., 1908. No. 342.

Chlorination.

Chlorination in California. Wilton E. Darrow. Discusses the Plattner and Greenawalt processes and describes modern plants. 2000 w. Min & Sci Pr—Oct. 31, 1908. No. 114.

Cobalt.

The Present Position of Cobalt, Ontario. Harold P. Davis. Gives statistics of production and shipment. Ills. 800 w. Eng & Min Jour—Oct. 31, 1908. No. 17.

The Fortunes of the Temiskaming & Hudson's Bay Mining Company. Alex. Gray. An account of the origin and work of this company at Cobalt, Ontario. 2500 w. Min Jour—Oct. 24, 1908. No. 75 A.

See also Ore Deposits, under MISCELLANY.

Colorado.

The San Juan Region, Colorado. Thomas T. Read. Describes the latest phases of development, reviewing its history. Ills. 3000 w. Min & Sci Pr—Nov. 7, 1908. Serial. 1st part. No. 234.

The Portland Mine in Cripple Creek District. C. P. Scates. An account of the methods of mining and ore treatment in this gold mine. Ills. 1800 w. Min Wld—Nov. 7, 1908. No. 157.

Cyaniding.

Home-Made Cyanide Plant. W. F. Boericke and B. L. Eastman. Describes a plant for treating low-grade tailings at small cost. 600 w. Min & Sci Pr—Nov. 21, 1908. No. 625.

Newer Ore-Treatment and Metallurgical Processes and Their Machinery. Charles C. Christensen. Deals with the latest practice in a few of the recently developed processes for silver and copper ores, and the appliances used. Ills. 3500 w. Engineering Magazine—Dec., 1908. No. 679 B.

Cyanide Mills, Guanajuato Development Co. Charles T. Rice. The Nayal mill shows the possibilities of cyaniding silver ores on a small scale. The interesting features of other mills are described. Ills. 3000 w. Eng & Min Jour—Nov. 14, 1908. Serial. 1st part. No. 257.

Zinc Dust Precipitation at Cerro Prieto. Robert Linton. An account of a plant in Mexico successfully using zinc dust for precipitation. 2500 w. Jour Chem. Met. & Min Soc of S Africa—Sept., 1908. No. 175 E.

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Dredging.

The Method and Cost of Gold Dredging by the Elevating Bucket. Describes its use, reporting costs. Ills. 2000 w. Engng-Con—Nov. 4, 1908. No. 120.

Hydraulic Mining.

See Yukon, under GOLD AND SILVER.

Idaho.

The Coeur d'Alene Mining District, Idaho. J. P. Rowe. Reviews the history and describes the methods of mining. Ills. 1600 w. Min Wld—Nov. 14, 1908. Serial. 1st part. No. 278.

Mexico.

Las Chispas Mines, Sonora, Mexico. B. E. Russell. The mining and ore treatment of rich silver deposits. Ills. 2000 w. Eng & Min Jour—Nov. 21, 1908. No. 409.

Hinds Consolidated Mines, Mexico. S. F. Shaw. A report of the mines of this company which yield lead, gold, silver, and other economic minerals. Ills. 1000 w. Min & Sci Pr—Oct. 31, 1908. No. 111.

Hostotipaquillo and the Lerma River. Ezequiel Ordoñez. Map and illustrated description of this mining region where old mines are now being developed by improved methods. The most valuable mineral is silver sulphide. 2500 w. Min & Sci Pr—Nov. 21, 1908. No. 624.

Nevada.

Progress on the Comstock Lode. R. L. Herrick. Reviews the history and difficulties that caused the shutting down, and the events that led to the reopening. Ills. 7000 w. Mines & Min—Nov., 1908. No. 31 C.

Mining and Milling at Virginia City, Nevada. G. E. Walcott. Reminiscences of the camp where milling of silver ore was first practiced, and where the square-set system of timbering was invented. Ills. 3000 w. Min Wld—Nov. 21, 1908. No. 461.

New Mexico.

The New Gold Camp at Sylvanite, New Mexico. Charles A. Dinsmore. An account of the discovery, transportation facilities and work being done. 2000 w. Min Wld—Oct. 31, 1908. No. 38.

New Zealand.

The Gold Mines of Blackwater and Reefton Districts, New Zealand. Gives the history, geology, and development of the mines of these districts. 4000 w. Min Jour—Oct. 31, 1908. No. 186 A.

Peru.

See same title, under COPPER.

Rand.

The Robinson Mine. J. B. Pritchford. A report of the most productive gold mine in the world at the present time. 2200 w. Min & Sci Pr—Oct. 31, 1908. No. 113.

Notes on Rand Mining. Tom Johnson. Reply to discussion of paper on this subject by the author. 13000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1908. No. 177 E.

Rand Mine Waters. F. W. Watson. Deals with waters for drinking and domestic uses, and for industrial purposes, especially for boiler feed supply. Also discussion. 7000 w. Jour S African Assn of Engrs—Sept., 1908. No. 60 F.

Rhodesia.

Small Mines of Rhodesia. B. I. Collings. Describes the nature of the ore bodies, the economic and industrial peculiarities of the country, and their effect on the methods of mining and milling adopted. 5000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1908. No. 176 E.

Tasmania.

The Lisle Goldfield, Tasmania. W. H. Twelvetrees. Specially considering the sources of the alluvial gold. 1600 w. Aust Min Stand—Oct. 14, 1908. No. 463 B.

Yukon.

Hydraulic Mining in the Yukon. R. E. W. Hagarty. Describes methods used. 4000 w. Can Engr—Nov. 6, 1908. No. 155.

IRON AND STEEL.

Alabama.

The Clinton Iron-Ore Deposits in Alabama. Ernest F. Burchard. Gives an outline of the geologic relations of the ores, describing particularly the ore of the Birmingham district, and discussing its relations and probable extent. Ills. 1600 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 686 D.

Blast-Furnace Gas.

The Purification and Economic Utilization of Blast-Furnace Gas (Epuration et Utilisation Economique des Gaz de Hauts-Fourneaux). Louis Detrez. Discusses the problem, methods and cost of cleaning the gas and the economy of its use in gas engines. 5000 w. Bul Sci d l Assn d Elèves—June-Oct., 1908. No. 500 D.

Bosnia.

Iron Making in Bosnia (Eisenhüttenwesen in Bosnien). A general brief review of the industry. Ills. 2300 w. Stahl u Eisen—Oct. 28, 1908. No. 549 D.

Dry-Air Blast.

Experience with the Gayley Dry Blast at the Warwick Furnaces, Pottstown, Pa. Edward B. Cook. A brief illustrated description of the Warwick plant, with account of its very satisfactory working. 5000 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 683 C.

Electro-Metallurgy.

Steel Making by the Girod Electrical

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Process. Brief illustrated description of the Paul Girod electric steel-making furnace. 1000 w. Ir Trd Rev—Nov. 12, 1908. No. 233.

Ingot Iron from the Electric Furnace. Trans. of article by B. Osann, in *Stahl und Eisen*. Gives results obtained with the Stassano furnace. Ills. 3500 w. Ir & Coal Trds Rev—Nov. 6, 1908. No. 330 A.

The Development of Electric Steel Plants (Zur Entwicklung der Elektrostahlanlagen). A table giving details of the various electric steel plants in the world. 2000 w. Stahl u Eisen—Oct. 7, 1908. No. 545 D.

An Electric Furnace with One Electrode and with a Conducting Hearth (Sur un Four électrique à une seule Electrode et à Sole Conductrice). M. Durnuis. Researches on such a furnace. Ills. 1500 w. Rev de Métal—Oct., 1908. No. 515 E + F.

See also Lash Process, under IRON AND STEEL.

Lash Process.

The Lash Steel Process. F. A. J. FitzGerald. Abstract of paper and discussion, before the Am. Elec-Chem. Soc. Describes the process, discussing the possibility of its application to the electric furnace. Ills. 1500 w. Ir Age—Nov. 5, 1908. No. 85.

New York.

Clinton Iron Ores in New York State. Data from a report issued by the Educational Department of the State, concerning a recent investigation of their extent and character. 2500 w. Ir Age—Nov. 12, 1908. No. 218.

Pennsylvania.

The Clinton Iron-Ore Deposits of Stone Valley, Huntingdon Co., Pa. J. J. Rutledge. Describes the ores and associated rocks, discussing their origin. Ills. 10500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 687 C.

Rolling Mills.

Three-High Rolling-Mill at Mossend Steel Works. Drawings and brief description. Plate. 400 w. Engng—Nov. 13, 1908. No. 446 A

New Electric Rolling Mill Plant at the Works of Messrs. Dorman, Long & Company, Limited. Illustrated detailed description. 3000 w. Ir & Coal Trds Rev—Oct. 30, 1908. No. 201 A.

Hydraulic Machines in English Rolling Mills (Einige hydraulische Vorrichtungen englischer Walzwerke). K. Rummel. Illustrates and describes apparatus and machines for various purposes. 3000 w. Stahl u Eisen—Oct. 14, 1908. No. 546 D.

Steel Making.

See Lash Process, under IRON AND STEEL.

Trade.

The Flow of Steel Through Consumption. Editorial on the movement of products of the steel industry. 2000 w. Ir Age—Nov. 26, 1908. No. 497.

LEAD AND ZINC.

Australia.

See Lead Milling, under ORE DRESSING AND CONCENTRATION.

Austria.

See same title, under COPPER.

France.

The Mining and Milling of Silver, Lead and Zinc Ores at Pierrefitte Mines, France. William Waters Van Ness. Reviews the history of these mines, describing conditions, mining methods, etc., and giving costs. Ills. 7000 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 684 C.

Mexico.

See same title, under GOLD AND SILVER.

Oklahoma.

Miami Lead and Zinc District in Oklahoma. Otto Ruhl. Describes the ore occurrence, difficulties in milling, and gives the capacity of some of the mills. Ills. 2000 w. Eng & Min Jour—Nov. 7, 1908. No. 150.

Zinc Smelting.

Zinc Smelting for Pigment. Evans W. Buskett. Information concerning the manufacture of zinc pigment. Ills. 1200 w. Min & Sci Pr—Oct. 31, 1908. No. 112.

The Method of Extracting Zinc in Australia. John Plummer. Describes recovering zinc from the waste of Broken Hill silver-lead mines. Ills. 1200 w. Min Wld—Nov. 7, 1908. No. 158.

MINOR MINERALS.

Aluminium.

The Development of the Aluminium Corporation, Ltd. Illustrated description of plants for the production of aluminium by the electro-thermal process. 6500 w. Elec Rev. Lond—Nov. 6, 1908. No. 310 A.

Notes on Aluminium. Prof. A. Humboldt Sexton. Its properties, compounds, minerals, purification, etc., are discussed in the present number. 3300 w. Mech Engr—Nov. 13, 1908. Serial, 1st part. No. 430 A.

Aluminium and Some of Its Uses. J. T. W. Echevarri. Read before the Inst. of Metals. Its manufacture, properties, methods of working and its applications are considered. 4000 w. Min Jour—Nov. 14, 1908. Serial, 1st part. No. 439 A.

Antimony.

Notes on Antimony. Prof. A. Humboldt Sexton. Considers its physical and chemical properties, its compounds, minerals, treatment, etc. Ills. 4000 w. Mech Engr—Oct. 30, 1908. No. 182 A.

We supply copies of these articles. See page 747.

Cement.

Cement Raw Meal Mixer and Stores. Details and illustrations of the cement works at Cambridge, Eng. 1200 w. Engr, Lond—Nov. 13, 1908. No. 452 A.

A Design for a Portland Cement Plant with a Car System for Transporting Materials. C. J. Tomlinson. Plans and description of a departure from accepted designs for this work. 1200 w. Eng News—Nov. 19, 1908. No. 375.

Manganese.

See Alloys, under MISCELLANY.

Oil.

The Shale Oil Industry of Scotland. D. R. Steuart. An account of the nature, extent and origin of the industry; its history, geology and methods. Ills. 7000 w. Ec-Geol—Oct.-Nov., 1908. No. 480 D.

The Oil Fields of Argentina. Brief account of a recent discovery and reference to previous discoveries. Map. 600 w. Engng—Oct. 30, 1908. No. 188 A.

Platinum.

Platinum at the Cracker Jack Mine, Douglas County, Oregon. H. B. Pulsifer. On the treatment of platinum-bearing black sands. 1000 w. Eng & Min Jour—Nov. 21, 1908. No. 408.

Rare Metals.

The Rare Metals. I. Beryllium. Charles Baskerville. The present article considers some of the minerals of beryllium. 1000 w. Eng & Min Jour—Nov. 7, 1908. Serial, 1st part. No. 149.

Turquoise.

Turquoise Mining, Burro Mountains, New Mexico. Edward R. Zalinski. Notes on how turquoise is mined, and a review of the geological features. Ills. 3500 w. Eng & Min Jour—Oct. 31, 1908. No. 15.

MINING.

Boring.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Electric Power.

Switchboards for Mine Power Plants. W. B. Clarke. Considers the equipment desirable and the reasons for certain arrangements. 3000 w. Mines & Min—Nov., 1908. No. 32 C.

See also Exhibitions, under MINING.

Engineering Ethics.

Professional Ethics. John Hays Hammond. The relation of the mining engineer to employers, to the public, and to personal interest. 3000 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 690 C.

Exhibitions.

Manchester Electrical Exhibition. The first of a series of illustrated articles describing especially the exhibits dealing with mining and quarrying. 3000 w. Col Guard—Nov. 6, 1908. Serial, 1st part. No. 318 A.

Explosives.

See same title, under COAL AND COKE.

Finance.

The Better Protection of Mine Investors. H. S. Munroe. Briefly considers prospecting, development and working, and the information that a company report should contain. 1500 w. Min Wld—Nov. 14, 1908. Serial, 1st part, No. 279.

Haulage.

An Electric Colliery Railway. Illustrated description of an installation at Chopwell Colliery, England. 1700 w. Elec Engng—Oct. 22, 1908. No. 70 A.

Some Economies in Underground Ore Haulage. G. E. Walcott. Discusses how to lay tracks, how to run a drift, switching devices, etc. Diagrams. 3000 w. Min Wld—Oct. 31, 1908. No. 37.

Hoisting.

The Influence of the Use of Back Steam for Shortening Hoisting Time on the Steam Consumption of Hoisting Engines (Der Einfluss der Fahrt mit Gegendampf zur Verkürzung der Fahrzeit auf den Dampfverbrauch von Fördermaschinen). Herr Moritz. Discusses an actual experience. Ills. 2000 w. Glückauf—Oct. 10, 1908. No. 554 D.

Labor.

The Kaffir Mine Laborer. Thomas Lane Carter. An account of conditions in South Africa, the mental and physical capabilities of the natives, their customs and their economic value as laborers. Ills. 10800 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 681 C.

Mine Waters.

A Method of Determining Ground-Water Flow during Shaft Sinking. (Ueber eine Methode zur Ermittlung der zur wältigenden Wasserzuflüsse beim Uebergang vom Schachtabteufen in totem Wasser zur Abteufarbeit auf der Sohle). Dr. Münster. Description and mathematical demonstration. Ills. 2800 w. Glückauf—Oct. 24, 1908. No. 556 D.

Shaft Sinking.

A Difficult Shaft Sinking Operation at Durwood, Minn. An account of methods used. 1000 w. Ir Trd Rev—Nov. 5, 1908. No. 108.

Note on a Problem During Shaft Sinking. Charles B. Saner. An account of methods of accomplishing difficult work in the shaft of the Turf Mines, Ltd., on the Rand. 2500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1908. No. 174 E.

Shaft Tubbing.

Tubbing for Modern Collieries. J. S. Barnes. Discusses the scientific design of tubbing. Diagrams. 3000 w. Engr, Lond—Oct. 23, 1908. No. 79 A.

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Subsidence.

The Law of Subsidence. Discusses British law and recent decisions. 1500 w. Col Guard—Nov. 13, 1908. No. 440 A.

Surveying.

A Few Suggestions on How to Survey a Mine. Charles W. Helmick. Briefly considers three methods, explaining the determination of a meridian, etc. 1500 w. Min Wld—Oct. 31, 1908. No. 39.

Tunnel Lining.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

ORE DRESSING AND CONCENTRATION.

Crushers.

See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Flotation Process.

Ore Dressing by Adhesion of Liquid Films. R. Stören. Reviews the principles of the Elmore process and other systems based upon similar principles. 4000 w. Eng & Min Jour—Oct. 31, 1908. No. 14.

Gold Milling.

How to Clean and Dress Amalgamating Plates. Justin H. Haynes. Useful hints and suggestions. 1500 w. Min Wld—Nov. 21, 1908. No. 462.

The St. George Treatment Plant (W. A.). Percy Ifould. A brief description of a modern plant. 1200 w. Aust Min Stand—Sept. 30, 1908. No. 178 B.

The Treatment of the Gold Ores of Hog Mountain, Alabama. T. H. Aldrich, Jr. An account of experiments made, and conclusions reached, concerning the treatment of certain refractory low-grade gold-ores. 2500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 682 C.

See also Colorado, Cyaniding, and Rhodesia, under GOLD AND SILVER.

Iron Ores.

See Magnetic Concentration, under ORE DRESSING AND CONCENTRATION.

Lead Milling.

Metallurgy of Broken Hill, New South Wales. Gerard W. Williams. Describes concentration methods. 6000 w. Eng & Min Jour—Nov. 7, 1908. No. 146.

See also France and Oklahoma, under LEAD AND ZINC.

Jigs.

See Washing, under COAL AND COKE.

Magnetic Concentration.

Notes on Some Recent Swedish Plants and Methods for Concentrating and Briquetting Iron Ores (Mitteilungen über einige neuere schwedische Anlagen und Verfahren für Aufbereitung und Briketteirung von Eisenerzen und Kiesabbränden). G. Franke. Illustrated description of latest developments in the Gröndal process. Serial, 1st part. 4800 w. Glückauf—Oct. 3, 1908. No. 552 D.

Sampling.

Principles of Machine Sampling. John A. Church. Discusses the controlling elements and the possible methods of remedying their faults. 2500 w. Eng & Min Jour—Nov. 14, 1908. No. 258.

Silver Milling.

Metallurgical Practice at Hacienda de la Union. Francisco Narvaez. Illustrated description of the present system of treatment at Pachuca, Mexico. 3000 w. Eng & Min Jour—Nov. 21, 1908. No. 406.

Stamp Mills.

Some Notes on the Gravitation Stamp Mill. R. C. Robinson. Describes the general design and construction and some details. 4000 w. Queens Gov Min Jour—Oct. 15, 1908. No. 460 B.

Wilfley Tables.

Experimental Work in Ore Concentration. John Allen Davis. Reports investigations made to determine the conditions of greatest efficiency in concentrating a classified product on tables. 1800 w. Eng & Min Jour—Nov. 7, 1908. No. 148.

Zinc Milling.

Improvements at the Oronogo Circle Mill No. 5. Otta Ruhl. Illustrates and describes equipment for setting and treating fine material. 1800 w. Eng & Min Jour—Nov. 21, 1908. No. 407.

MISCELLANY.

Alloys.

The Alloys of Manganese (Les Alliages de Manganèse). A. Portevin. Summarizes the results of Prof. Tammann's researches on the alloys of manganese with nickel, lead, phosphorus, antimony, silicon, and tin. Also alloys of magnesium with bismuth, cadmium, potassium, sodium, nickel, lead, antimony, tin, thallium, and zinc. Ills. 500 w. Rev de Mètal—Oct., 1908. No. 516 E + F.

British Columbia.

Mining in British Columbia. A general review of the industry. Ills. 9000 w. B C Min Rec—Aug., 1908. No. 82 B.

Canada.

The Taxation of Mineral Resources in Canada. O. D. Skelton. Reviews the measures adopted, with comments. 3500 w. Can Min Jour—Nov. 1, 1908. No. 44.

Mineral Springs.

The Hot Mineral Springs of Savoie (Les Sources Thermo-Minérales de la Savoie). J. Révil. A discussion of their origin. Ills. 6000 w. Rev Gen d Sci—Oct. 30, 1908. No. 524 D.

Ore Deposits.

Origin of Cobalt Silver Ores of Northern Ontario. Reginald E. Hore. Gives results of study in field and laboratory, and conclusions. 4000 w. Ec-Geol—Oct.-Nov., 1908. No. 481 D.

The Relation of Copper to Pyrite in

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the Lean Copper Ores of Butte. James F. Simpson. Gives results of investigations. Ills. 1800 w. Ec-Geol—Oct.-Nov., 1908. No. 483 D.

A Genetic Classification of Minerals. William H. Emmons. Indicates briefly the principal conditions under which the most important minerals are formed, giving tables and explanatory notes. 4500 w. Ec-Geol—Oct.-Nov., 1908. No. 482 D.

The Localization of Values in Ore Bodies and the Occurrence of Shoots in Metalliferous Deposits. Hjalmar Sjögren. Notes concerning the Scandinavian copper and lead-silver mines. 2500 w. Ec-Geol—Oct.-Nov., 1908. No. 484 D.

A New Theory of the Genesis of Brown Hematite Ores; and a New Source of Sulphur Supply. Charles Catlett's discussion of the paper by H. M. Chance. 1500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 689 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Communication.

Telegraph Service on Railways (Etude du Service Télégraphique dans les Chemins de Fer). M. Pellarin. Report of a commission appointed to study conditions in Belgium, Italy, Switzerland, and Holland. 4000 w. Ann d Ponts et Chaussées—1908-III. No. 505 E + F.

Signalling.

The State of the Art of Railway Signalling. J. P. Simmen. A general review, with a description of the Simmen system. 4500 w. Can Engr—Nov. 20, 1908. No. 405.

Railway Signalling: Its Defects, and Suggestions for Removing Them. A. Gardiner. Abstract of paper before Leeds Loc. Soc. of Inst. of Elec. Engrs. Describes the author's system of train working with engine cab signals. 2000 w. Elect'n, Lond—Nov. 6, 1908. No. 313 A.

Controlled Manual Block Signaling. A. D. Cloud. Describes this system as used on some of the western roads. 3000 w. Sig Engr—Nov., 1908. No. 281.

Safety Appliances on the Java Railways (Dutch Indies). L. Dufour. Describes the appliances adapted for interlocking the signals and switches on lines carrying but little traffic. Ills. 2200 w. Bul Int Ry Cong—Oct., 1908. No. 169 G.

See also Drawbridges, under CIVIL ENGINEERING, BRIDGES.

Train Operation.

Extension of the "A. B. C." Rules on Northern Pacific. An explanation of this system of train operation and the instructions for the change. 1500 w. R R Age Gaz—Nov. 6, 1908. No. 128.

MOTIVE POWER AND EQUIPMENT.

Air Pumps.

Care of the Air Pump. G. W. Kiehm. Suggestions for repairs and care. 1500 w. Ry & Loc Engng—Nov., 1908. No. 9 C.

Electrification.

Inaugural Address to the Leeds Local Section of the Institution of Electrical Engineers. H. E. Yerbury. (Abstract.) Reviews the progress made in the electrification of tramways and railways, discussing probable future developments. 1200 w. Elect'n, Lond—Nov. 6, 1908. No. 312 A.

Report of the Swiss Commission on Electrification (Mitteilungen der Schweizerischen Studienkommission für elektrischen Bahnbetrieb). W. Wyssling. Results of an investigation of the possibilities of electric traction on Swiss railways. Ills. Serial, 1st part. 3000 w. Schweiz Bau—Oct. 17, 1908. No. 561 B.

See also Trunk Lines, under STREET AND ELECTRIC RAILWAYS.

Freight Cars.

A General Service Freight Equipment Car. Detailed description of a car of the convertible type. Ills. 900 w. Am Engr & R R Jour—Nov., 1908. No. 91 C.

Standard Fifty-Ton Gondola Coal Car. Illustrated detailed description of cars for the Virginian Railway. 1200 w. Am Engr & R R Jour—Nov., 1908. No. 88 C.

The Construction of Large Railway Wagons. From the presidential address of Jas. Hewlett before the Midland Jun. Gas Engng. Assn. Compares flat and hopper wagons, and ten and twenty-ton wagons. 2500 w. Ir & Coal Trds Rev—Oct 30, 1908. No. 202 A.

Locomotive Design.

The Efficiency of Locomotives and Its Relation with Their Chief Dimensions and the Speed. Albert Frank, in *Ann. für Gewerbe und Bauwesen.* Gives calculations of value in designing locomotives for special purposes. 9800 w. Bul Int Ry Cong—Oct., 1908. No. 170 G.

Design of a Four-Cylinder Compound Locomotive (Calcul d'une Locomotive Compound à Quatre Cylindres). Marcel Ubaghs. Illustrated description of the method of obtaining the principal dimensions. 3500 w. All Indus—Oct., 1908. No. 527 D.

Locomotive Economy.

Locomotive Characteristics. Lawford

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H. Fry. Gives chart for the operation of single expansion locomotives, with explanatory notes. 1800 w. Am. Engr & R R Jour—Nov., 1908. No. 89 C.

Locomotives.

Details of DeGlehn Compound Locomotives. Drawings and description of the cylinders and of a novel boiler fitted to these locomotives. 1400 w. Am Engr & R R Jour—Nov., 1908. No. 90 C.

New Standardized Locomotives, Harriman Lines. Illustrates and describes types, giving specifications for the mogul type. 1500 w. Ry & Engng Rev—Oct. 31, 1908. No. 40.

Goods Locomotive for the Caledonia Railway. View, outline, sketch, and description of a new engine. 500 w. Engng—Oct. 23, 1908. No. 77 A.

Mogul for the Iowa Central. Illustration, with description of a 2-6-0 type for freight service. 700 w. Ry & Loc Engng—Nov., 1908. No. 8 C.

Ten-Wheeler for the Lackawanna. Illustration and description of recent engines for passenger service, weighing 217000 lbs. 900 w. Ry & Loc Engng—Nov., 1908. No. 11 C.

"Pacific" Type Compound Locomotive for the Paris-Orleans Railway. Illustrated detailed description of a 4-6-2 type of engine. 600 w. Engr, Lond—Oct. 30, 1908. No. 200 A.

Mallet Articulated Compound Locomotives for Santo Domingo. Illustrated detailed description. 700 w. R R Age Gaz—Nov. 27, 1908. No. 630.

Twelve-Wheel Articulated Compound Freight Locomotive of the Hedschas Railway (Sechsachsige kurvenbewegliche Güterzug-Verbundlokomotive der Hedschasbahn). H. Keller. Detailed description. Ills. 2700 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1908. No. 601 D.

Locomotive Speed.

See Speed, under ELECTRICAL ENGINEERING, MEASUREMENT.

Locomotive Superheating.

The Application of Superheated Steam to Locomotives (Note sur l'Application de la Vapeur Surchauffée aux Locomotives). Maurice Demonlin. Deals with the results obtained on the Italian State Railways and the Western Railway of France. Ills. 10000 w. Rev Gen d Chemins d Fer—Oct., 1908. No. 521 G.

Locomotive Trucks.

The Mechanics of the Locomotive Truck. L. S. Randolph. A discussion of the principles governing the three types of truck developed. Mathematical. 3000 w. Stevens Ind—Oct., 1908. No. 486 D.

Locomotive Valve Gears.

Young Rotary Valve and Gear for Locomotives. Illustrated detailed description of the recent improvements in this valve gear. 1000 w. R R Age Gaz—Nov. 13, 1908. No. 244.

Setting Walschaert Valve Gear. R. S. Mounce. Rules for a specific case, but of general use. Diagrams. 900 w. Am Engr & R R Jour—Nov., 1908. No. 92 C.

Motor Cars.

Accumulator Cars of the Prussian State Railways (Akkumulatoren Doppelwagen der Preussischen Staatsbahnen). Illustrated description and details of performance. 2000 w. Elektrotech Zeitschr—Oct. 29, 1908. No. 615 B.

Gasoline and Oil Engines for Railway Motor Cars (Motore a Petrolio e ad Oli Pasanti, a Combustione senza Accensore, per Automotrici Ferroviarie, Moderabile, Invertibile e ad Azione Diretta sull' Asse del Veicolo). Enrico Mariotti. Ills. Serial. 1st part. 3000 w. Ing Ferro—Oct. 16, 1908. No. 542 D.

Refrigeration.

The Transportation of Perishable Freight in Refrigerator Cars (Le Transport des Denrées Alimentaires par Wagons Frigorifiques). L. Piaud. Describes recent French practice. Ills. 3000 w. Génie Civil—Oct. 3, 1908. No. 533 D.

Shops.

Improvements at the Works of the Kingston Locomotive Company, Kingston, Ontario, Canada. Henry Goldmark. Describes the enlargement and modernizing of these works. Ills. 3500 w. Can Soc of Civ Engrs—Oct. 29, 1908. No. 284 N.

A Modern Steel Car Plant. Horace H. Lane. Describes the Detroit shops of the American Car & Foundry Co. 3500 w. Ir Age—Nov. 12, 1908. No. 216.

Modern Plants for Building Steel Cars. Horace H. Lane. An illustrated study of modern plants, their equipment and methods. 5000 w. Jour Assn of Engng Socs—Sept., 1908. No. 351 C.

The J. J. Beijnes Car Shops at Haarlem (De Koninklijke Fabriek van Rijtuigen en Spoorwagens, firma J. J. Beijnes te Haarlem). J. J. Beijnes. Description of this plant in Holland. Plate. 6500 w. De Ingenieur—Oct. 10, 1908. No. 616 D.

NEW PROJECTS.

Erie.

The Guymard Cut-Off. Illustrates and describes the short cut on the Erie R. R. between Guymard, N. Y., and Newburgh Junction. 1200 w. R R Age Gaz—Nov. 6, 1908. No. 130.

PERMANENT WAY AND BUILDINGS.

Crossings.

The Kinsman Road Improvement in Cleveland, Ohio. D. M. Taylor. An illustrated description of extensive grade crossing elimination. 1500 w. Ry & Engng Rev—Nov. 21, 1908. No. 465.

Railroad Crossings. W. C. Sparks. Read before the Cent. Elec. Ry. Assn. Discusses

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construction, maintenance, etc. 1500 w. Elec Ry Jour—Nov. 21, 1908. No. 368.

Curves.

See Rail Stresses, under PERMANENT WAY AND BUILDINGS.

Elevated Railways.

Some Features of Construction of the South Side Elevated Railroad. J. N. Darling. Describes improvements on this Chicago line, to meet the transportation requirements of rapid transit. Ills. Discussion. 8500 w. Jour W Soc of Engrs—Oct., 1908. No. 354 D.

The Experimental Section of Suspension Railway at the Rosenthal Tor in Berlin. Translated from *Zeit. des Ver. Deut. Eisenbahnverwaltungen.* An illustrated account of the structure and of its influence on the traffic. 2300 w. Bul Int Ry Cong—Oct., 1908. No. 171 G.

Rail Joints.

Wheel-Carrying Rail-Joints and Tie Preservation. Max Barschall. Discusses the construction and trials. Ills. 900 w. Bul Int Ry Cong—Oct., 1908. No. 168 G.

A Study of Rail Joints (Etude des Joints des Rails). M. Pellarin. Report of a Commission appointed to make investigations in Belgium, Italy, Holland and Switzerland. Ills. 8000 w. Ann d Ponts et Chaussées—1908-III. No. 504 E + F.

Rails.

The Hardness and Wear of Steel Rails. Editorial on the service of rails and the improved methods of testing for hardness. 1700 w. R R Age Gaz—Nov. 27, 1908. No. 628.

Method of Reporting and Studying Rail Failures on the Harriman Lines. Taken from a paper by J. D. Isaacs, read before the Am. Main. of Way Assn. Outlines the methods of studying the statistics of rail failures. 2500 w. R R Age Gaz—Nov. 13, 1908. No. 243.

Rail Stresses.

A Study of Rail Pressures and Stresses in Track Produced by Different Types of Steam Locomotives on Curves. E. E. Stetson. From Bul. No. 104, of the Am. Ry. Engng. & Main. of Way Assn. Preface by W. C. Cushing. 5000 w. Eng News—Nov. 26, 1908. No. 640.

Roundhouses.

Wabash Locomotive Terminal at Decatur, Ill. Illustrated description of interesting features. 2000 w. R R Age Gaz—Nov. 6, 1908. No. 133.

Stations.

New Lackawanna Station at Scranton. Illustrated description. 1000 w. R R Age Gaz—Nov. 13, 1908. No. 242.

The Manhattan Terminal of the Central Railroad of New Jersey. Illustrated detailed description, confined principally to the passenger station. 1700 w. R R Age Gaz—Nov. 6, 1908. No. 129.

The New Chicago Terminal for the Chicago and Northwestern Railway. Alfred Hoyt Granger. A statement of conditions at Chicago and brief illustrated description of this fine building and its arrangements. 2500 w. Archt Rec—Dec., 1908. No. 494 C.

Ties.

Steel Tie and Concrete Tie Construction. Charles H. Clark. Abstract of paper read before the St. Ry. Assn. of the State of N. Y. Information concerning these ties, comparing their cost with oak tie construction. 2000 w. Elec Ry Jour—Nov. 14, 1908. No. 236.

See also Rail Joints, under PERMANENT WAY AND BUILDINGS.

Track Construction.

Track Superstructure in Tunnels. Brief illustrated description of the type being considered by the Pennsylvania R. R. Also editorial. 1700 w. R R Age Gaz—Nov. 6, 1908. No. 135.

The Detailed Cost of Laying Side Tracks and Switches, Including Labor and Materials. Gives eight examples of the actual cost of this sort of work on a western railway. 1200 w. Engng-Con—Nov. 4, 1908. No. 121.

Track Depression.

Track Depression of the Seaboard Air Line Railway at Birmingham, Ala. Philip Aylett. Illustrated detailed description of the general features, construction, and requirements. 3500 w. Eng News—Oct. 1, 1908. No. 210.

Track Maintenance.

Railway Maintenance of Way. E. E. R. Tratman. From a paper read before the Road. & Main. of Way Assn. Discusses problems in track construction and maintenance. 2500 w. Ry & Engng Rev—Nov. 21, 1908. No. 466.

Tunnels.

See Track Construction, under PERMANENT WAY AND BUILDINGS; and Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Yards.

The Gardenville Yard of the New York Central Lines. Plan and description of this freight terminal near Buffalo, N. Y. 2500 w. Eng Rec—Nov. 7, 1908. No. 137.

TRAFFIC.

Car Carding.

Carding of Cars. J. E. Stumpf. Read before the Cent. Assn. of R. R. Officers. Discusses the form of cards to be used, their color, etc. 800 w. R R Age Gaz—Nov. 6, 1908. No. 134.

Car Distribution.

Car Distribution and Car Shortage. Report of Franklin K. Lane before the Nat. Assn. of Ry. Com. Discusses remedies for car shortage, etc. 3000 w. Ry & Engng Rev—Nov. 7, 1908. No. 160.

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STREET AND ELECTRIC RAILWAYS

Austria.

The Rittner Railway in the Tyrol (Die Rittnerbahn, Tirol). Egon E. Seefehlner. Illustrated detailed description. Serial. 1st part. 2800 w. Elek Kraft u Bahnen—Oct. 14, 1908. No. 591 D.

Brakes.

Report of the Tramways and Light Railways Association Committee on "Braking Arrangements and Sanding Gear on Tram Cars." 5000 w. Elect'n, Lond—Nov. 13, 1908. Serial. 1st part. No. 438 A.

Car Barns.

See Fire Protection, under CIVIL ENGINEERING, WATER SUPPLY.

Cars.

New Cars of the Chicago Railways Company. Illustrated description of the new pay-as-you-enter cars. 2500 w. Elec Ry Jour—Nov. 7, 1908. No. 110.

Pay-as-You-Enter Cars for the Third Avenue Railroad Company, New York. Illustrated description. 2000 w. Elec Ry Jour—Nov. 21, 1908. No. 367.

Conductors.

Location of Conductors Other Than Third Rail. Report of the Committee on Standard Location for Conductors, Am. Ry. Assn. 800 w. R R Age Gaz—Nov. 27, 1908. No. 631.

Hamburg.

The Blankanese-Ohlsdorf City and Suburban Railway (Die Stadt- und Vorortbahn Blankanese-Ohlsdorf). H. v. Glinski. A detailed description of this railway at Hamburg-Altona. Ills. Serial. 1st part. 2700 w. Zeitschr d Ver Deutscher Ing—Oct. 3, 1908. No. 597 D.

Interurban.

Electric Railways in the Ohio Valley Between Steubenville, Ohio, and Vanport, Pennsylvania. George B. Francis. Illustrated description of a high-grade interurban road. 5500 w. Pro Am Soc of Civ Engrs—Nov., 1908. No. 648 E.

Locomotives.

New Locomotives of the Chicago City Railway. Illustrated description of 40-ton electric locomotives for switching purposes. 1000 w. Elec Ry Jour—Nov. 21, 1908. No. 366.

Motors.

See Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Power Losses.

Economy in Current Consumption. C. J. Spencer. Discusses the sources of loss and the remedies on tramways. 2500 w. Tram & Ry Wld—Nov. 5, 1908. No. 432 A.

Power Stations.

See Central Stations, and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Railroad Crossings.

See Crossings, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Rails.

T-Rail in Paved Streets. R. A. Dyer, Jr. Read before the St. Ry. Assn. of the State of N. Y. Information concerning their use, construction and service. 1200 w. Elec Ry Jour—Nov. 14, 1908. No. 237.

Sanding Gears.

See Brakes, under STREET AND ELECTRIC RAILWAYS.

Single-Phase.

Constants of Single-Phase Railway Circuits. A. W. Copley. Report of tests giving data of interest. 2500 w. Elec Jour—Nov., 1908. No. 208.

St. Clair Tunnel.

Electrification of the St. Clair Tunnel. Illustrated detailed description of the tunnel, equipment, etc. 6000 w. Elec Ry Jour—Nov. 14, 1908. No. 235.

Subways.

Washington Street Subway. Brief illustrated description of the new tunnel built by the Boston Transit Commission. 2000 w. Elec Ry Jour—Nov. 28, 1908. No. 498.

Washington Street Tunnel, Boston. John S. Hodgson. Illustrated description of this recently opened tunnel for the Boston Rapid Transit System. 3000 w. R R Age Gaz—Nov. 27, 1908. No. 629.

Ties.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Track Construction.

Method of Constructing Concrete Foundation for Street Railway Track Using a Special Mixer Mounted on a Car. Illustrated description. 700 w. Engng-Con—Nov. 4, 1908. No. 119.

Trunk Lines.

The Introduction of Electric Traction on Trunk Lines (Ueber die Einführung des elektrischen Zugbetriebes auf Vollbahnen). E. Frischmuth. A general review of progress in Europe and America. Ills. 8000 w. Elek Kraft u Bahnen—Oct. 24, 1908. No. 592 D.

Wire Suspension.

Catenary Trolley Construction. Discussion of a paper by Oliver S. Lyford. Ills. 8000 w. Pro Am Soc of Civ Engrs—Oct. and Nov., 1908. No. 649 each E.

We supply copies of these articles. See page 747.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

Recent Improvements in Lifting Magnets.

THE first commercial lifting magnet was placed in service in this country about thirteen years ago. This magnet was designed by S. T. Wellman for handling plates and slabs, and proved fairly satisfactory for such service. The design was later refined and improved upon by E. B. Clark, then electrical engineer for the South Works of the Illinois Steel Co. The manufacture of lifting magnets of both the Wellman and Clark types was taken up by the Electric Controller & Mfg. Co. (then The Electric Controller & Supply Co.) more than ten years ago. A special magnet testing machine was designed and installed and much valuable data bearing on the design of lifting magnets was secured.

Many magnets of the Clark type have been manufactured and sold and have given excellent results in the handling of smooth homogeneous material such as plates, blooms and slabs. These magnets, however, were useless for handling rough and detached material such as pig iron, crop ends and scrap. A magnet which would readily lift a steel ingot weighing 10,000 pounds would not lift a single pig of iron weighing 100 pounds. Many attempts were made to perfect a magnet for handling pig iron and scrap, since obviously the large amounts of such raw material handled by tedious hand methods at all steel and iron works and foundries offered a tremendous field for the saving of labor, providing a practical lifting magnet could be developed for the purpose. Perhaps the first experiments in this direction which gave promise of commercial results were made at the West Seneca plant of the Lackawanna Steel Co., under the direction of E. D. Edmondson and L. R. Palmer, a lifting magnet being constructed which actually lifted pig iron, though in rather small quantity, taking into consideration the weight of the magnet and its current consumption. The first commercially successful lifting magnet for handling pig iron, scrap and miscellaneous magnetic material was placed on the market by the Electric Controller & Mfg. Co. in March, 1905. This magnet was built in two sizes, commercially known as No. 1 and No. 2 Type S magnets. Over 150 of these magnets have since been placed in service and at a conservative estimate saved to the iron and steel trade of this country at least half a million dollars in the cost of handling material within the past year. This type of magnet has also been introduced in Germany and England.

In view of these facts there can be no doubt that Type S magnets as manufactured by the Electric Controller & Mfg. Co. have become satisfactory and reliable tools—more dependable in fact than the cranes which carry them. This company, however, has not been content to rest upon the satisfactory results thus far obtained with its Type S magnets, but has been constantly at work on improvements both in the direction of dependability and in increased efficiency in the handling of material. Unquestionably a successful lifting magnet must withstand in service more severe abuse and rough handling than any other type of electrical apparatus. In operation it is suspended from the hook of a crane (frequently not equipped with a lowering brake) and may be dropped at high speed upon the material to be lifted. In service it will be swung against cars, charging boxes, piles of pig iron, etc., and must be capable of withstanding the blows and shocks which result. It must

operate under all weather conditions irrespective of rain or snow, and its insulation must withstand a voltage much higher than line voltage due to the inductive kick which occurs when the circuit of the magnet is opened. Its winding must not be injured by the large amount of heat which is necessarily generated within it, but preferably also should not be damaged by external heat when the magnet is called upon to handle hot material.

Among the accompanying cuts, Fig. 1 is a typical cross-section of a Type S A magnet and shows the arrangement of parts which by experience has been found to meet the severe and exacting requirements of service. In Fig. 1, A is the body or frame work of the magnet, which is an annular casting of special electrical steel heavily ribbed on both its upper and outer surfaces. The ribs serve to add largely to the surface available for dissipating heat and are so disposed as to stiffen the magnet case mechanically and at the same time to add to the cross-section of the magnetic circuit. B is the core of the magnet, which is surrounded by the winding C. This winding is composed of a series of coils each wound with a conductor in the form of a copper ribbon or strap, the turns of which are insulated with asbestos ribbon. Neighboring coils are mechanically separated and electrically insulated by non-combustible insulating discs D. The coils are wound upon a heavy brass form E which resembles a spool with one head removed. This form serves to support the coils during the process of winding and insures coils of uniform and perfect shape, since there is no danger of springing or otherwise distorting the winding. After the last or uppermost coil is wound and the outer disc of insulation in place, the entire winding is rigidly clamped to the form by means of radial straps F, which are bolted and locked in place, thus making the winding and the brass form which carries it a rigid unit. The completed winding is then dried in a steam heated chamber under a vacuum and when the initial drying process is completed the winding is impregnated with a plastic insulating compound—first under the influence of a vacuum and then under air pressure, and finally is again dried under a vacuum. This results in a winding not only fire-proof—not a particle of combustible material being used in its make-up—but what is of still greater importance, the winding is thoroughly water-proofed. The completed winding is then placed in the magnet case.

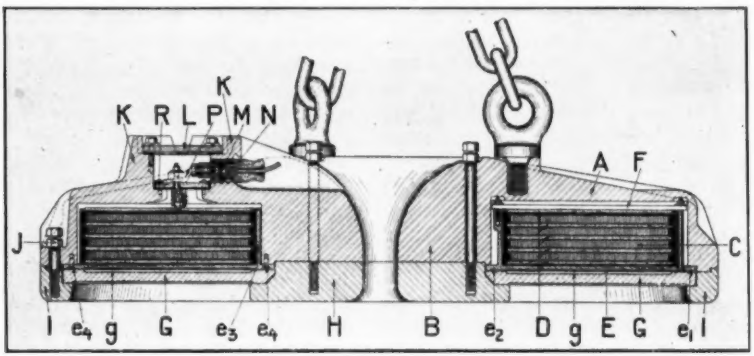


FIG. I.

It will be noted that the form E is provided with an outer flange e1 and an inner flange e2 in addition to the central upwardly-extending flange e3 which centrally supports the winding. The inner and outer flanges are carefully finished and engage with finished surfaces on the inner aud outer pole faces of the magnet case, thus completely sealing the lower face of the winding chamber, a

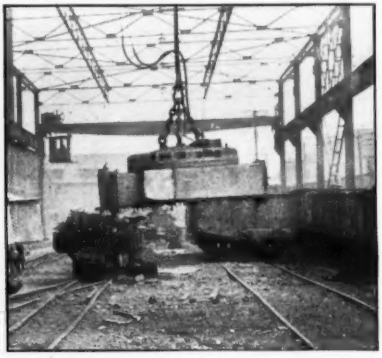
water-tight joint being insured by clamping the flanges in place with screws e4, e4, spaced four inches apart entirely around the flanges e1 and e2. Since the winding is clamped to the form E by the radial clamps F and the form E is clamped in the magnet case by screws placed four inches apart entirely around its inner and outer edges, it will be readily seen that the winding is rigidly held against displacement — a result which cannot be reliably obtained by means of wedges or similar expedients. With the winding thus assembled in the magnet case the lower face of the coil form E is covered by a heavy annular plate of non-magnetic manganese steel, G, which in turn is held in place by pole shoes H and I, bolted respectively to the inner and outer poles of the magnet case. Both of the pole shoes are provided with shoulders which protect the clamping bolts from shearing strains. The heads of the outer clamping bolts J are located between adjacent ribs on the outer surface of the magnet case, where they are protected from abrasion.

The wearing qualities of manganese steel are well known, this material being used for frog and switch points on modernly equipped railways—both electric and steam. The Electric Controller & Mfg. Co. early investigated the fitness of this material for use in wearing plates for lifting magnets, and about two years ago a quality of manganese steel was found which answered the purpose admirably, it being both hard and tough and at the same time practically non-magnetic. In the cross-sectional view it will be noted that the manganese steel plate, G, carries raised shoulders around its inner and outer peripheries, by means of which the plate is made to seat against the magnet poles and an air space or cushion is left under the winding at g. This results in the shocks taken by the outer plate G being transmitted directly to the magnet frame, instead of being taken by the winding as would necessarily be the case if only a single bottom plate were used. The pole shoes are so disposed with respect to the outer plate, G, that none of the clamping surfaces can become battered over, and therefore the plate, G, may always be readily renewed. It will be seen that the entire lower or wearing face of the magnet is renewable and that these renewals can be readily effected in the field, there being no necessity of in any way exposing or disturbing the winding or breaking the water-tight joint between the coil form E and the frame of the magnet.

The arrangement of terminals also deserves attention, since no matter how good the design in other respects if the terminal construction be weak, trouble is certain to result from this cause.

In Type S A magnets the terminal cavity is surrounded by raised walls, K, K, cast integral with the magnet case and of such thickness as to be as strong as the magnet case itself. The terminal cavity is closed at the top with a heavy steel cover, L, which seats against a gasket to form a water-tight joint and is firmly bolted in place, the heads of the bolts being protected from abrasion by the walls of the terminal cavity. All of

the terminal parts are thus enclosed in a water-proof box of steel. As in the earlier Type S magnets the terminals themselves are of the plug type, which permits of quick attachment and detachment of the service wires. Numerous improvements, however, have been made in the details of construction. The female members, M, of the terminal are enclosed in an insulating tube so that a ground or short circuit cannot result even if the service wires are left hanging from the crane with current on. The insulating tubes are each encased in a steel tube to prevent abrasion of the insulation and these steel tubes fit close-



ly in babbitted openings N in the side of the terminal chamber. The male members, P, of the plug connectors are mounted upon a heavy plate, R, of fireproof insulating material, which closes the entrance to the winding chamber and is seated upon a gasket to effect a water-tight joint. The plugs proper are separable from the terminals by removing the nuts which hold them in place. The plugs and also the plate, R, may therefore be removed without throwing any strain on the connections to the winding, the connections consisting of loops of very flexible copper ribbon, these loops being stowed away in the box-like ends of the terminal studs. This construction permits of great flexibility and at the same time makes it impossible for the flexible leads which connect to the two ends of the magnet winding to come into accidental contact. These features of construction indicate how carefully the design of Type S A magnets has been thought out and worked out from a mechanical and electrical standpoint.

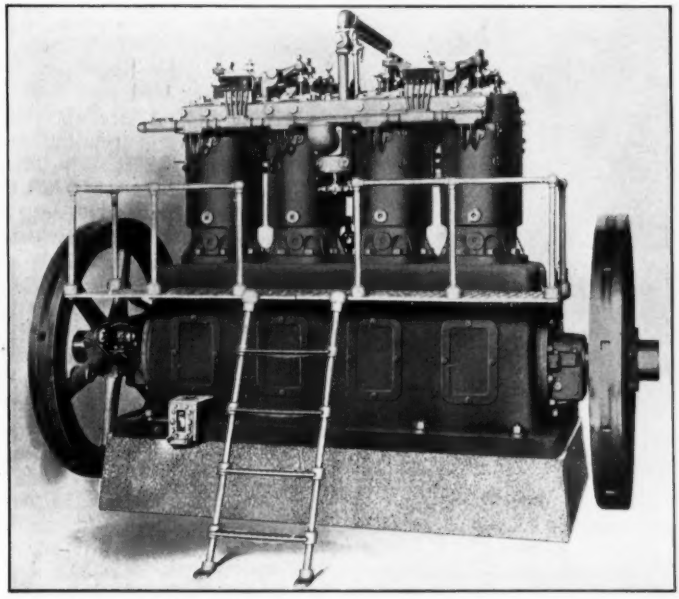
In addition to these structural features the Electric Controller & Mfg. Co. have incorporated in the design of Type S A magnets, the results of long experience and careful study of the best proportions for securing maximum efficiency in handling material. By maximum efficiency is meant the ability to handle the largest amount of material in a given time with minimum total consumption of current. In this respect the results obtained with Type S A magnets far surpass any results which have been obtained in the past. As an instance, the No. 4 Type S A magnet, forty inches in diameter, lifts substantially as much as older forms of magnets of fifty inches in diameter, with substantially the same current consumption, but weighs two thousand pounds less. Comparing the performance of the two magnets on a five-ton crane having a 25 H.P. hoist motor, with equal lifts, the No. 4 S A magnet has the advantage of 2,000 pounds in total load to be lifted, or 20 per cent of the total hoisting capacity of the crane. This will mean a saving in current consumption of 20 amperes on the part of the hoist motor, and by virtue of this lower current consumption and lighter load the hoisting speed will be higher and the amount of material handled in a given time will be materially increased. Proportionable increases in efficiency are shown by the No. 5 and No. 6 Type S A magnets, the No. 6 magnet being the most powerful commercial lifting magnet which has ever been constructed.

Four Cylinder Vertical Gas Engine.

THE accompanying illustration gives an excellent view of a type of vertical gas engine for electric lighting, pumping and general power purposes made by the Bruce-Meriam-Abbott Co., of Cleveland, Ohio.

A noticeable feature of this engine is its simplicity, no parts or pipes having been removed for the purpose of taking

the photograph here shown. A rear view would show only the governor shaft and exhaust manifold. The most valuable feature of this engine is the element of duplication: each cylinder is the duplicate of the other; the inlet valves are all duplicate; the exhaust valves and the rocker arms which operate the valves are all interchangeable, any one of the eight fitting into the place of any other. The four-cylinder engines makes a perfect mechanical balance without the use of counterweights, while the frequency of impulse gives to the crank a uniform turning effort. The starting is simplicity



itself. There is no shifting of cams or rollers and no changing of the lever regulating the combustion mixture. By simply turning on the air pressure and opening full the gas cock the engine will start positively and uniformly.

This type of machine is equipped with special double timers. The design is such that each cylinder is furnished with two sparks, each independent of the other, and each timer receiving its current from a separate source. A further unique feature of this ignition is that each timer may be removed from the engine for adjustment without in any way affecting the running of the engine.

Full details may be had from the Bruce-Meriam-Abbott Co., Cleveland, Ohio.

Drill Chuck and Collets.

THE Wizard quick-change drill chuck and collets make it easy to use all sizes and shapes of tools—drills, taps, reamers, counter-bores, or special tools of any kind—in rapid succession without stopping the machine. A slight resistance to the outside collar with the hand while the spindle is in motion overcomes the tension of the spiral spring within and throws the key slot in the chuck open so that the collet will either fall out or slip into the slot. The spring then throws the collar around to "closed" position, closing the key slot and securely locking the collet in place. Thus a touch to the collar releases one tool, and another tool is inserted with another touch. The motion of the spindle itself does the work.

It is claimed that this is the only chuck and collet that holds the tool rigid and perfectly centered, without any loose-

ness or "play." Wizard collets are the only collets provided with a ring or flange to serve as a shoulder against the hand in pushing the tool up into the chuck and in catching it when released. The cone-shaped taper on the upper end of collets not only helps to hold the tool rigid and center it, but also makes it much easier to get the collet started into the chuck.

Wizard chucks are machined from best steel, hardened and ground inside and out. Wizard collets are drop-forged from the best steel, machined, hardened, and ground. The drive keys are not pins set in or a pin running through. The whole collet is one solid piece of steel. Collets are furnished either with standard Morse holes or are sent blank. Blank collets are not hardened and may easily be bored to receive the straight shanks of drills, taps, reamers, etc. An ordinary mechanic can fit up a score of tools with collets in a half day's time. Blank collets may be sent 5/1000 inch over size so that they may be hardened and ground after being fitted to the shank. There are numerous ways of "driving" straight shanks in such collets, and usually every tool man has his own ideas in this respect. As good a way as any is to pass a hardened pin through both collet and tool shank, or if the shank is too small for this, to "dub" it off flat and pass the pin so as to engage the flat part. Heavy set-screws may also be used to advantage, or a "tang" may be ground on the end of the shank and the tool driven with a drift slot as a regular Morse taper shank. In all cases it is best to bore blank collets for a driving fit.

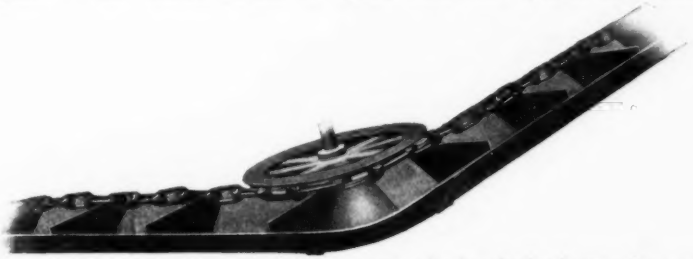
A Wizard outfit consists of the chuck and one collet for each tool in the series of operations. Manufactured by the McCrosky Reamer Co., Meadville, Pa, who will send fuller information on request.

Coal Conveying Machinery Aboard Ship.

THE coaling of steamships has been the subject of technical discussion for a number of years. The attempts of engineers to evolve mechanical apparatus that would operate successfully with a fair measure of economy have called for favorable editorial comment, and the necessity of so equipping vessels pointed out and the adoption of proper facilities strongly urged. More than passing notice is therefore deserved of the fueling equipment planned by C C. Lacey, Marine Supt. of the Great Northern Steamship Co., for the twin-screw steamer *Minnesota,* plying regularly between Seattle and the Orient. This vessel, with a gross tonnage of 28,000, is the largest cargo-carrying ship in the world; she is 630 feet long, 73 feet 6 inches beam, 56 feet deep, and is capable of a speed of 15½ knots. In her accommodations for 200 cabin passengers, she is equal in all points of excellence to any of our modern floating palaces.

It is evident that the coaling of a vessel so pretentious in all respects as the *Minnesota* is an important factor: it means that the coaling outfit must be strong, rugged and durable; also the machinery must be compact in order to fit the small space usually available in ocean steamers. After investigation these points were decided in favor of the Dodge chain conveyor—one of the standard devices made by the Link-Belt

Company, Philadelphia. This type of conveyor—well known in engineering practice dealing with transportation of materials on land—has for its principal feature a removable block of malleable iron inserted between the chain links, and so shaped that the chain may adapt itself to any turn in a vertical or horizontal plane. This feature makes it possible to run the conveyor around a rectangular path in a steel trough under the main deck of the steamship, and serve bunkers, having a total capacity of 3,400 tons, on both sides of the boat.



A longitudinal bulkhead running the entire length of the vessel and making of it practically two ships, emphasizes the utility of the conveyor, as there is no need of changing the vessel's position, or that of the barge, to procure duplicate broadside loading: delivery can be made to every part of the bunkers without interruption, or the starboard side may be supplied by the conveyor and the port side fed direct through the hatch, both operations being simultaneous.

Steel flights, or pushing blades, 8½ inches wide by 20 inches long, are attached to the chain (¾-inch size), at intervals of 33 inches, the normal capacity of the machine being 90 tons per hour at a speed of 125 feet per minute. Bituminous coal of a size that will pass through a 5-inch mesh screen is fed to it through hatch chutes. This first delivery is made by means of tub hoists averaging 1,000 lbs. of coal at a lift, and at best a somewhat slow and tedious process, but the only feasible method because of the awkward barges from which the supply is taken. Notwithstanding these crude facilities, the machine has justified the precedent of its installation by paying for itself in two voyages. The cost of hand-coaling at Seattle reaches as high as $2.00 per ton, practically a prohibitive price to a vessel such as the *Minnesota*.

Discharge to the bunkers is through the bottom of the conveyor-trough, which is fitted with sliding doors, or gates, each being opened and closed by means of a hand wheel actuating a rack-and-pinion gear. Provision is made for a reserve storage supply of 1,800 tons forward of the bunkers. This is served by two Link-Belt bucket elevators running in water-tight steel casings, and so located as to deliver at the rate of 45 tons an hour directly in front of the boilers. Each elevator is made up of 7 inch by 12 inch malleable-iron buckets spaced 16 inches apart on Ley bushed chain.

The installation is electrically operated. A 20 h.p. General Electric motor drives the conveyor, and both elevators are driven from a similar motor of 10 h.p. capacity, alternate operation being provided for by clutch on line shaft.

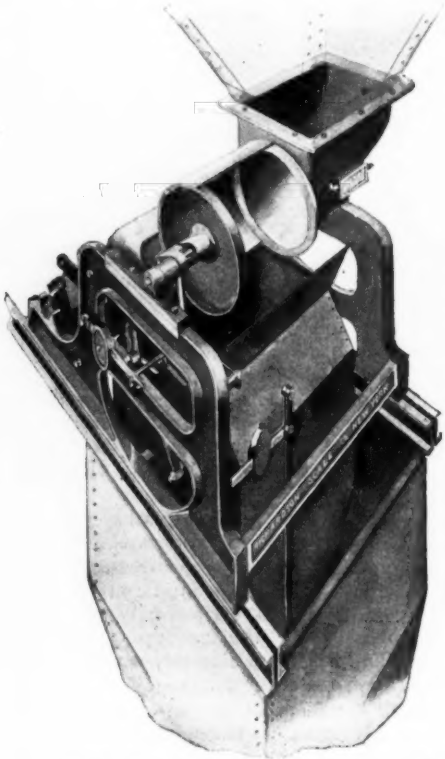
The Dustless Testing Track.

THE problem of preserving macadam on motor roadways appeared in its most intense form when the Thomas B. Jeffrey Company, at Kenosha, Wisconsin, undertook to build and maintain a half mile track for testing their automobiles. It is the custom at this factory to give all the Rambler cars a test of 200 miles driving on the testing track. The output of the factory is very large, so that 15 or 20 cars are running at high speed over the track every hour of the day. Ordinary macadam would, of course, fail under such a test, and the dust would be unbearable, especially at

the turns. Various oil treatments and compounds were experimented with, and the Tarvia treatment was finally adopted. It has been found entirely satisfactory. The surface is without dust, is impervious to water and is so elastic that wear on the tires has been greatly reduced. The success of Tarvia on the Rambler track has been so marked that it has led to the use of this material on all the roads surrounding the factory.

Automatic Coal Scale.

THE automatic scale for weighing coal has heretofore been limited in its application owing to the varying size of coal, since it has not been possible to



weigh by an automatic medium other than coal crushed to pieces of 6 inches in maximum dimension, and it has only been possible to weigh even such sizes on comparatively large machines.

There has been recently installed at the New York Central & Hudson River Railroad Power Station at Port Morris, N. Y., an automatic scale of much wider scope, which though of comparatively small individual weighing capacity, is capable of handling pieces of 15 inches in diameter, and similarly designed scales can be made to handle in suitable quantities coal as large as 30 inch pieces if necessary.

The coal is delivered to the power station by barges, and these are unloaded by grab buckets, discharging into a large bunker. Beneath the opening of this bunker is a track on which locomotives run, but the bunker is tapped on its sloping side to feed the automatic scale. The coal is delivered through a hopper bolted to the bunker into the scale proper, and this machine has cast iron side frames, which are carried on 8 inch channels connected to I beams. On these side frames is carried an equal armed beam supporting at equal distances from the fulcrum a weight box and a hopper for the material. These two when empty are arranged in weight to balance each other, and for whatever quantity of coal is required up to the capacity of the scale, standard dead weights are placed in the box.

When the exact quantity of coal has passed into the weighing hopper, the feed gate of the scale automatically closes and the hopper is discharged into a tapering spout, which carries the coal into the power house. The machine is one of 1500-pounds capacity, and is capable of handling about 100 tons per hour. A new feature of this machine is the feed gate and chute. Users of automatic scales are familiar with the ordinary type of under-cut gate, employed to cut off a vertical head of coal. There is a propensity for a lump of coal to wedge between the cast iron chute and this gate, so that it refuses to close or open. There has always been a difficulty in passing large lumps, which would choke the inlet to the scale, but the chief trouble has been due to inability to raise the feed gate when it is closed, owing to the head of coal carried upon it. It has been impossible to force back the coal on the

gate to allow it to open, despite the pressure exerted by the weights in the box.

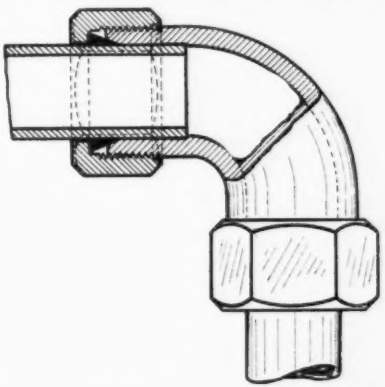
This new type of side feed chute and gate entirely overcomes these difficulties. The chute is of a sloping type feeding into a gate of a construction resembling the drum of a concrete mixer, and thus will admit whatever pieces will come out of the bunker. The angle of the chute is about 40 degrees and is of such construction that it is impossible for coal to bridge in it. The outlet from the drum gate is greater in area than the inlet from the steel chute. Therefore, any piece which will enter the drum gate can pass out into the weighing bucket. Owing to the side feed from the sloping chute only a small quantity of coal is carried at any time in the bottom of the drum, so that when the gate is closed there is not a heavy head of coal upon it. When the gate is raised the power to raise it is only one-third previously found necessary, the material having plenty of space in the drum gate moves with the gate, and there is no friction due to head of coal upon the gate, so that the gate readily opens and allows the coal to pass into the weighing bucket. This improvement applied to the Richardson scale enables it to weigh practically any size material.

The cut illustrates the Richardson improved coal scale so made to weigh run-of-mine coal. For further particulars application should be made direct to the manufacturers, Richardson Scale Co., 3 Park Row, New York, and 122 Monroe street, Chicago.

Union-Cinch Pipe Fitting.

THOSE who have had actual experience in trying to make up a neat, mechanical looking job of small piping with the ordinary threaded pipe and tapped fittings will remember having wondered why there had not been invented some more practical way in which to accomplish the work. It seems probable that the work of threading pipe and getting a good fit for the threads could be accomplished at a factory or in the shop much better than it is often done by means of a set of dies in the hands of more or less inexperienced workers, who are often obliged to thread a piece by holding it with a Stillson wrench while they try to run the die on by hand; and after all the care possible has been exercised in making up a job where the pressures are rather severe, it is unusual not to find a number of leaks; and we have all noticed that these leaks usually occur where it is least convenient to get at them, to give the pipe another turn to take them up.

The Sight Feed Oil Pump Co. of Milwaukee have gotten out something that



gets around the majority of these difficulties, based on the belief that it is more practical to do the work of threading in the shop than it is to do it in the field. They present an interesting line of pipe fittings which they term the Union-Cinch type. These fittings are made in sizes corresponding to standard iron pipe up to one inch, and are especially designed for use in connection with the oil pumps and oilers manufactured by them.

It is possible to use ordinary rough pipe with these fittings, if care is exercised in filing the ends of the pipe round and smooth; but the builders of the fittings are prepared to furnish smooth drawn steel tubing corresponding to the iron pipe sizes on the outside diameter. This tubing has No. 16 gauge wall in the ¾-inch and 1-inch sizes, and 18 gauge wall in smaller sizes, and has, therefore, a very much larger carrying capacity than ordinary pipe. In fact, their ⅛-inch pipe size will carry almost

as much as the ordinary ¼-inch iron pipe. This steel tubing is very cheap, is thoroughly annealed, readily bent, and when it comes to paying the bill for labor and putting up a job of pipe work, the Union-Cinch system brings to light a number of strong arguments in its favor. A hack saw and monkey wrench are all the tools that are required, except where some very fancy work has to be done, in which case a bending rig of some sort is very convenient. Each fitting is a union, and the piping may be taken down at any point where a fitting is inserted. The joint is made by screwing down the outside nut, which presses a thin, tapered shell into the annular cavity around the pipe, between it and the fitting, as shown on sectional cut. These nuts may be pulled up good and hard and the soft cone shell will make an absolutely tight joint around the tubing, which is good for 1,000 lbs. pressure per square inch; or, in fact, is absolutely tight under any pressure that the tubing will stand.

Where it is desirable to have a nice looking job, brass pipe may be used, although in cases where nickel-plating is done, the steel tubing will nickel-plate just as nicely as brass pipe and is much cheaper.

A New Lamp Testing Wattmeter.

A PRACTICAL demonstration of the high efficiency of the new metallic filament incandescent lamps will often aid in their introduction. All that is necessary to make such a test is a simple indicator that will show the relative watt consumption of metallic and carbon filament lamps, and for this purpose the lamp testing watt indicator has been designed by the General Electric Company.

This watt indicator is constructed on the Thomson inclined coil principle, and has a scale marked directly in watts, at different voltage values. The moving element is mounted in jeweled bearings. The case consists of a single aluminum alloy, on each side of which is a brass dome. At the top there is an Edison screw plug, and at the bottom a lamp receptacle.

Although the lamp testing wattmeter is intended for use with Edison sockets and lamps equipped with the Edison base, an adapter can be supplied permitting its use with either the Thomson-Houston or Westinghouse socket or lamp base.

To use the instrument, the plug is screwed into a lamp socket and the lamp

to be tested is inserted in the receptacle at the bottom of the instrument. The pointer will then indicate the watts consumed by the lamp. The plug end of the instrument is equipped with a spring contact end, permitting an extra turn so that the scale may always be in full view.

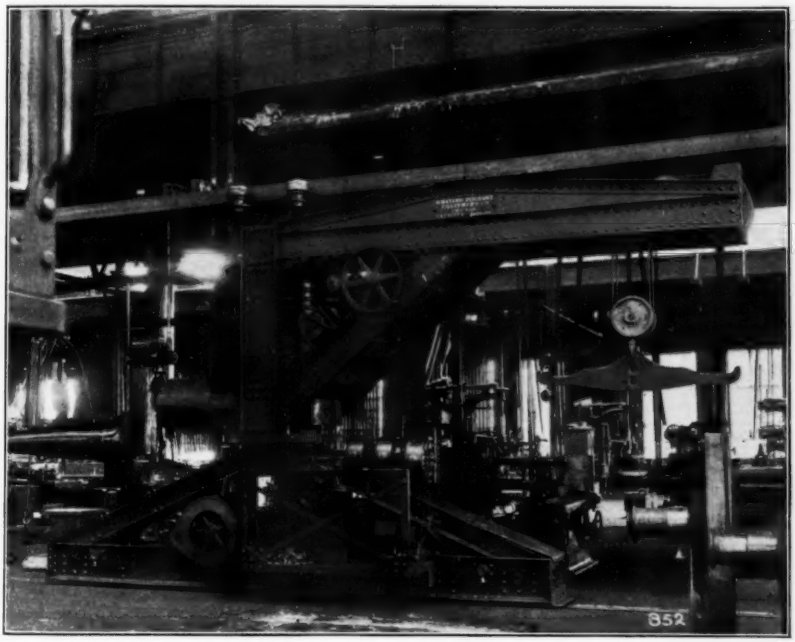
The instrument is provided with a multiple scale, permitting direct readings when used on 100, 105, 110, 115 and 120 volts. For intermediate voltages, readings may be interpolated. The capacity of the winding is 1½ amperes and the maximum scale marking is 125 watts. The size of the instrument is such that

it can be conveniently carried in the pocket.

The General Electric Co., Schenectady, N. Y., will be glad to furnish further particulars regarding this indicator upon application.

Electric Walking Jib Crane.

THE function of this jib crane installed in the Burnside Shops of the Illinois Central Railroad by the Whiting Foundry Equipment Co., Harvey, Ill., is to pick up the wheels and axles, distribute them through the shop



to wheel lathes or elsewhere if desired, and also to place wheels in storage.

This crane is of seven tons capacity, four motor, twelve feet effective radius —supported on one track rail, top of mast being supported by I beam track, requiring minimum floor space. All wearing parts are easily accessible for oiling and repairs. It was specially designed for this railroad and for the work it will perform. A feature to be noted is that of the low head-room.

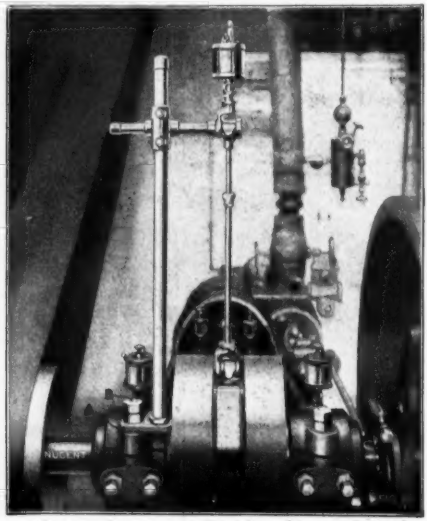
The four motors are distributed as follows in the working of this crane: One for traveling crane; one for trolley; one for rotating jib, and one for hoisting.

An important feature is the fact that load is always in absolute control, being automatically sustained at all times. The hoisting gearing is provided with improved double automatic safety brake, so arranged that the load may be raised and lowered by power and be automatically sustained. This brake attachment consists of two independent brakes, one electrical, and one mechanical. The electrical brake is operated by an electric solenoid in circuit with the hoisting motor, and so arranged as to come automatically into action when the electrical current is off the hoisting motor circuit.

The manufacturers claim a maximum of efficiency for this crane for the service it is designed to perform, together with a minimum of cost as to installation and repairs.

An Oiling Device.

THE accompanying illustration represents a device for oiling the crank pin of a high speed center crank engine, manufactured by Wm. W. Nugent & Co., 18-30 West Randolph street, Chicago. The object of this design of an oiler is to provide a continuous conduit or tube from a stationary oil supply or oil cup to the crank pin when the engine is in motion. The tubes telescope and are long enough to permit of a lap when the engine is on the bottom center. The tubes and joints are made of hardened steel, and when the device is put on



the engine properly, that is, so that the tubes and joints will not bind when the engine is running, it will last a great many years. The longest time one of these has been in operation is on an engine running 300 R. P. M. ten hours a day for three years, and upon examination the joints showed no wear and very little wear on the tubes. The whole device is self lubricating, so the maintenance of this device is very small in comparison with the able and positive way in which it lubricates the crank pin.

This device has been known to take all the pound out of an engine. In a number of places it has saved its cost by preventing shut downs in less than a day's run. The manufacturers claim they have sold over a thousand of these devices and have yet to receive the first complaint; they claim to be only too anxious to ship it to anybody on thirty days' trial, and if it is not satisfactory, to take it back and say nothing.

Personals.

—Edwin P. Jones, president and general manager of the Vulcan Iron Works, Wilkesbarre, Pa., died recently.

—J. R. Gordon has accepted the position of manager of power apparatus sales for the Western Electric Co. for its southern territory, with headquarters at Atlanta.

—J. N. Richards, who for many years was general sales manager of the Standard Paint Co., has associated himself with the Ernst Wiener Co., 50 Church Street, New York.

Joseph A. MacLennan has resigned his position at the Philadelphia works of the Link-Belt Company to accept the presidency of the Wilmot Machinery Company, New Orleans.

—Leicester Allen, the inventor and designer of the Allen dense-air ice machine used on warships, yachts and merchant vessels, has recently effected an improvement of valve in the compression of air, ammonia, carbonic acid, illuminating and other gases. Mr. Allen plans to make his invention available generally by concessions of right to manufacture on a royalty.

Industrial Notes.

—Wilbraham-Green Blower Co. announce the removal of their works to Pottstown, Pa.

—The Babcock & Wilcox Co. has purchased from The Rust Boiler Co. its patents and plant located at Midland, Pa., and will continue the manufacture, at that point, of the Rust water tube boiler.

—Ernst Wiener Co. announce the removal of their offices in New York City to the Hudson Terminal, 50 Church Street. Their Pittsburg office will in the future be located in the Union Bank Building, with John T. Cawley in charge.

—Northern Water Softener Co., Madison, Wis., advise that they have just closed

a contract with D. D. Pendleton, Frick Bldg. Annex, Pittsburg, who will represent them in Pittsburg and territory adjacent thereto. He is their exclusive agent in the Pittsburg district.

—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest, London, New York and Shanghai, announce that they have opened a branch under their own name for the sale of machine tools, woodworking machines and small tools at No. 14 Akashicho Tsukiji, Tokio, Japan, under the management of James G. Brown.

—The Bruce-Merriam-Abbott Co., Cleveland, have recently received the following contracts: two 125 H.P. vertical four-cylinder natural gas engines to be shipped to Salamanca, N. Y.; one 125 H.P. producer gas engine to be shipped to McHenry, Ill.; one 135 H.P. producer gas engine to be shipped to Milwaukee; one 135 H.P. engine to be shipped to the Willard Storage Battery Co., Cleveland; one 15 and one 55 H.P. to be shipped to the Corpus Christi Church, Buffalo, and one 27 H.P. engine to the Starr Plating Works, Buffalo.

—One of the most important orders recently booked in the electrical field is that for about 2,500 horsepower of induction motors for the Clark Thread Company, Newark, N. J. The order itself is of considerable size, but its chief importance is its being the beginning of the electrification of these mills, probably the most extensive cotton mills in the United States. The mill has been driven by several steam engines; and this purchase of induction motors is the first step in electric drive. The motors are 5,500 volt, 60 cycle, 3 phase machines and the present order aggregates about 2,500 horsepower, the motors ranging from 25 to 150 horsepower each.

—The December number of the *General Electric Review*, published by the General Electric Co., Schenectady, N. Y., contains the following articles: The New Incandescent Lamps, by Francis W. Willcox; The Great Southern Lumber Company, by John Liston; The Energy of Steam, by J. W. Kirkland; Installation and Operation of Switchboards, by S. W. Mauger; Variable Ratio Converters, Part II, by Chas. P. Steinmetz; Electric Annealing and Tempering Furnaces, by J. E. Kearns; L-3 Brush Holder, by Edward Mink; Type I Ammeters and Voltmeters, by D. P. Burleigh; Transformer Magnetizing Currents; An Electrically Driven Brewery, by C. A. Raymond, and An Electric Motor in a Grist Mill, by Edward L. Cooley.

—W. B. McVicker has resigned as vice-president and eastern manager of the Dearborn Drug & Chemical Works, and has incorporated the W. B. McVicker Company, with offices in the U. S. Realty Building, 115 Broadway, New York. A new and complete laboratory and factory are in course of construction and will be completed about December 1st. They will have exceptional facilities for general analytical work and the manufacture of high class products. A specialty will be made of scientific preparations for treating boiler feed-waters and hydraulic systems also high grade lubricants. The personnel of the company includes Charles M. Eddy, Albert E. Carpenter, Joseph F. Hammill, William J. Schatz, G. Frank Duemler and Frank J. Zink.

—Last June the Isthmian Canal Commission invited bids for a large quantity of bronze globe and angle valves fitted with seats and discs that were capable of being renewed. Considerable competition resulted and after the authorities at both the Isthmus and Washington had carefully considered the bids submitted by a number of manufacturers, they decided, a few days ago, to place the order comprising upwards of 7,000 valves, in sizes ranging from ¼ to 3 inches exclusive, for the Lunkenheimer "Renewo" renewable seat and disc regrinding valve. This valve is practically indestructible, inasmuch as every part that is subjected to any possible wear can be easily, quickly and cheaply renewed. These valves are guaranteed for 200 pounds working pressure and are manufactured by The Lunkenheimer Company, Cincinnati.

—The New Process Raw Hide Co., Syracuse, manufacturers of pinions and cut gears of all kinds, is about to construct an addition to its present plant. The new addition will consist of two stories and a basement, 60 ft. x 80 ft., extending east on Plum Street from the company's present

plant. The construction is to be of steel and brick with cement floors and will increase the available floor space by over 13,000 square ft. The cost of the new building, complete, will be from $25,000.00 to $30,000.00, and the company has machinery on order for delivery during the next two months approximating $12,000.00, same consisting principally of automatic turret lathes, bevel gear planers and grinding machines. An additional hardening furnace for treating automobile transmission gears and drive gears will also be installed.

—L. J. Wing Mfg. Co., New York, report the sale of turbine blowers to the following: Empire Wood Working Co., New York; American Can Co., Brooklyn; Russell, Burdsall & Ward, Portchester, N. Y.; Laurie Engine & Mach. Co., Montreal; W. W. Bethel, Tolosa, Oaxaca, Mexico; Forbes & Wallace, Springfield, Mass.; J. Landis Shoe Co., Palmyra, Pa.; Berlin & Jones Envelope Co., New York; F. W. Devoe & C. T. Raynolds Co., New York; Maryland Steel Co., Sparrow Point, Md.; Brooklyn Union Gas Co., Brooklyn; J. H. & C. K. Eagle, Shamokin, Pa.; Arrow Lakes Lumber Co., Arrowhead, B. C.; United Piece Dye Works, Lodi, N. J.; Gutta Percha & Rubber Mfg. Co., Toronto; Treverton Electric Light Co., Treverton, Pa., and disc fans to Salt Lake Electric Supply Co., Salt Lake City; L. Strauss & Son, New York; Berlin & Jones Envelope Co., New York; Royce Laundry Co., Springfield, Mass.; D. M. Frank & Co., New York; Merchants' Refrigerating Co., New York; Crescent Athletic Club, Brooklyn; Rochester Electric Motor Co., Rochester; Sprague Electric Co., New York.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

BURY COMPRESSOR CO., Erie, Pa.—Illustrated catalogue describing air compressors for every service. 6 by 9 in.

NATIONAL BRAKE & ELECTRIC CO., Milwaukee—Booklet No. 386 illustrates and describes air compressors for industrial service. Also gives dimensions, capacities, etc. 6 by 9 in.; pp. 24.

Air Pumps.

WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J.—Bulletin No. 103 illustrates and describes various types of Wheeler-Edwards air pumps. Also contains views of a number of large steam-turbine installations in which these pumps are used. 8 by 10½ in.; pp. 32.

Arbor Presses.

EDWIN E. BARTLETT, 364 Atlantic Ave., Boston—Pamphlet devoted to an illustrated description of arbor presses for use in forcing arbors into and out of work. 4 by 9 in.; pp. 16.

Boiler Feed Regulators.

AMERICAN BOILER ECONOMY CO., North American Bldg., Philadelphia—Catalogue illustrating and describing the Copes boiler feed regulator for regulating automatically the feed water to steam boilers. 6 by 9 in.; pp. 32.

Chucks.

CUSHMAN CHUCK CO., Hartford, Conn.—Condensed catalogue and price list treating of chucks and face plate jaws. Illustrated. 4 by 7 in.; pp. 44.

Cooling Towers.

EDWIN BURHORN, 71 Wall St., New York—Catalogue describing cooling towers and illustrated with views showing some recent installations. 8¼ by 6 in. pp. 46. Also two catalogues illustrating and describing internally fired boilers and riveted pipe.

Cranes.

CASE MANUFACTURING CO., Columbus, Ohio—Several bulletins illustrating and describing electric traveling jib cranes. Also contain views showing some recent installations. 12½ by 9½ in.

MORGAN ENGINEERING CO., Alliance, Ohio—Booklet showing reproductions of photographs of cranes and other types of machines recently installed by them, together with a list of users of each. 4 by 9 in.; pp. 64.

Drop Hammers.

BILLINGS & SPENCER CO., Hartford, Conn.—Illustrated catalogue describing drop hammers, trimming presses, hot saws, heating furnaces, etc. 5 by 7½ in.; pp. 42. Also catalogues treating machinists' tools; automobile forgings and tools, and fine tools and specialties.

Electrical Equipment.

WESTERN ELECTRIC CO., 463 West St., New York—Two booklets giving instructions for the installation and operation of designs "E" and "L" generators and motors. Illustrated. Also bulletin No. 5370 illustrating and describing steam turbines. 8 by 10¾ in.; pp. 12.

Elevators.

OTIS ELEVATOR CO., 17 Battery Place, New York—A series of pamphlets illustrating and describing plunger elevators, electric elevators, both passenger and freight, hand power elevators, escalators, and gravity package conveyors.

Engineering Instruments.

BAUSCH & LOMB OPTICAL CO., Rochester—Booklet, vest pocket size, giving directions, with diagrams, for using and adjusting the engineer's wye level, dumpy level and the transit instrument as well as other useful information. Also contains the Solar Ephemeris for 1909 and directions for using the Saegmuller solar attachment. Illustrated. 3 by 5¼ in.; pp. 40.

Expanded Metal.

EXPANDED METAL ENGINEERING CO., 225 Fifth Ave., New York—Catalogue illustrating and describing the expanded metal system of fireproof building construction and reinforced concrete construction. 8 by 5 in.; pp. 176.

Feed-Water Heaters.

ALBERGER CONDENSER CO., 95 Liberty St., New York—Catalogue illustrating and describing Wainwright feed-water heaters and expansion joints. 6 by 9 in.; pp. 40. Also catalogues devoted to illustrated descriptions of cooling towers, high vacuum apparatus, condensing apparatus and centrifugal pumps.

Flexible Shafting.

STOW MANUFACTURING CO., Binghamton, N. Y.—Catalogue No. 11 illustrates and describes flexible shaft for portable drilling, tapping, reaming, wood boring, emery grinding, etc., driven by either electric motor or rope transmission. 6 by 9 in.; pp. 80.

Galvanizing.

U. S. ELECTRO-GALVANIZING CO., 1 Park Ave., Brooklyn—Catalogue illustrating and describing dynamos and electro-plating outfits for cold galvanizing and other electro-plating. 4¼ by 9¼ in.; pp. 30.

Gears.

BOSTON GEAR WORKS, Norfolk Downs, Mass.—Catalogue E2 illustrates and describes steel spur, bevel, miter and helical gears; racks, steering devices, etc. 3½ by 6 in.; pp. 96.

Grinders.

RANSOM MFG. CO., Oshkosh, Wis.—Catalogues illustrating and describing motor and belt driven grinders and buffers. Dry and disc grinders are also given a place. 6 by 9 in.; pp. 24.

Hack Saws.

DIAMOND SAW & STAMPING CO., Buffalo—Catalogue illustrating and describing, together with prices, hack saw blades and frames, emery wheel dressers and cutters, and power hack saws. 5¼ by 8 in.; pp. 20.

Heating and Ventilating Apparatus.

MASSACHUSETTS FAN CO., Watertown, Mass.—Loose-leaf catalogue devoted to an illustrated description of heating, ventilating, drying fans, blowers and engines. 7 by 4 in.; pp. 124.

Industrial Cars.

WONHAM-MAGOR ENGINEERING WORKS, 29 Broadway, New York—Catalogue illustrating and describing industrial steel and wooden cars, rails, track fastenings, switches, portable track and turntables. 6 by 9 in.; pp. 162.

Lathes.

FITCHBURG MACHINE WORKS, Fitchburg, Mass.—Illustrated catalogue describing the "Lo Swing" lathe. 6 by 9 in.; pp. 40.

Locomotives.

H. K. PORTER CO., 1207 Union Bank Bldg., Pittsburgh—Catalogue illustrating and describing steam and compressed air locomotives in a variety of sizes and designs. The catalogue is well printed and bound in cloth. 6 by 9 in.; pp. 224. Also a catalogue treating of compressed air haulage. 6 by 9 in.; pp. 80.

Lubricators.

STERLING LUBRICATOR CO., Rochester, N. Y.—1909 catalogue illustrating and describing automatic force-feed lubricators for the lubrication of the cylinders of steam and gas engines, pumps, air compressors, bearings, etc. Also contains price list. 5 by 7¼ in.; pp. 36.

Machine Knives.

LOMING COES & CO., INC., Worcester—Catalogue illustrating and describing machine knives for all purposes. 6 by 9 in.; pp. 32.

Manila Rope.

C. W. HUNT CO., West New Brighton, N. Y.—Pamphlet No. 082 describes Manila rope for the transmission of power, pile driving and hoisting. Illustrated with views showing recent installations. 3¼ by 6 in.; pp. 32.

Milling Cutters.

BECKER-BRAINARD MILLING MACHINE CO., Hyde Park, Mass.—Illustrated catalogue No. 55 describing milling cutters suitable for both vertical and horizontal milling machines, also gear cutters suitable for automatic gear cutting machines. 4 by 6 in.; pp. 102.

Mine Fans.

SIROCCO ENGINEERING CO., 138 Cedar St., New York—Illustrated catalogue treating of the mechanical ventilation of mines. Also contains views of plants in which these fans have been installed, together with brief descriptions of the same. 9 by 6 in.; pp. 40.

Molding Machines.

TABOR MANUFACTURING CO., 18th and Hamilton Sts., Philadelphia—Catalogue illustrating and describing hinged molding machines. 6 by 9 in.; pp. 16. Also catalogues treating of tool grinders and metal saws.

Paints.

LOWE BROS. CO., 450-452 E. Third St., Dayton, O.—Cloth bound catalogue treating of paints and colors for structural and railway uses. 6 by 9 in.; pp. 82.

Roller Presses.

KUTZTOWN FOUNDRY & MACHINE CO., Kutztown, Pa.—Illustrated catalogue describing continuous roller presses for pressing pulp and slushy materials. 10 by 7 in.; pp. 24.

Sash Operating Apparatus.

LORD & BURNHAM CO., Irvington-on-Hudson, N. Y.—Catalogue No. 6 describes apparatus for opening and closing hinged and pivoted sash.

Illustrated with views showing power houses, factories, foundries, and manufacturing plants in which this device has been installed. 8 by 10 in.; pp. 48.

Saw Machinery.

COVEL MANUFACTURING CO., Fisher Bldg., Chicago—Illustrated catalogue describing complete automatic equipment for making, sharpening, tensioning, brazing, and retoothing all kinds of saws. 6 by 9 in.; pp. 88.

Shears.

INTERNATIONAL ELECTRIC & ENGINEERING CO., 148 Chambers St., New York—Catalogue illustrating and describing beam shears, coping machines and bar and angle cutters. Also gives weights and dimensions. 9 by 12 in.; pp. 12. Circular No. 12 treats of hand-power tools for structural iron work. 4 by 9 in.; pp. 14. Catalogue No. 50 describes punches made of forged steel. Illustrated. 6 by 5½ in.; pp. 24.

Spray Pumps.

GOULDS MANUFACTURING CO., Seneca Falls, N. Y.—Booklet illustrating and describing a partial line of spray pumps. Their 1909 spray pump catalogue is now ready for distribution.

Steam Engines.

HOOVEN, OWENS, RENTSCHLER CO., Hamilton, Ohio—Well-printed catalogue illustrating and briefly describing Hamilton-Corliss vertical cross compound engines. 9¼ by 12¼ in.; pp. 16.

FRICK CO., Waynesboro, Pa.—Catalogue devoted to an illustrated description of Corliss steam engines. 6 by 9 in.; pp. 56. Also a catalogue treating of refrigerating and ice-making machinery. Illustrated with views showing some recent installations. 6 by 9 in.; pp. 170.

Steam Separators.

HOPPES MANUFACTURING CO., Springfield, Ohio—Well-printed catalogue describing vertical and horizontal separators. Oil eliminators, exhaust heads and feed-water heaters and purifiers are also treated. Illustrated. 6 by 9 in.; pp. 32.

Steam Shovels.

VULCAN IRON WORKS CO., Toledo, Ohio—Catalogue illustrating and describing steam and electric power shovels, together with partial specifications. Also contains views showing the shovels in operation. 9 by 6 in.; pp. 118.

Steam Specialties.

CROSBY STEAM GAGE & VALVE MFG. CO., 97 Oliver St., Boston—Cloth bound catalogue illustrating and describing vacuum and pressure gages, recorders, gage testers, whistles, valves, sight-feed lubricators, etc. Also gives prices and dimensions. 6 by 9 in.; pp. 220.

Steel Sheeting.

GEORGE W. JACKSON, INC., 175 W. Jackson Blvd., Chicago—Catalogue describing interlocking steel sheeting for cofferdams, piles, bridge foundations, etc. Illustrated. 10 by 7 in.; pp. 70. Also a catalogue treating of steel ribs and lagging for construction of bridge piers, retaining walls, concrete foundations, reinforced concrete buildings, etc. Illustrated with views showing work on which steel ribs and lagging were used in forming the concrete. 10 by 7 in.; pp. 56.

Time Stamps.

STROMBERG ELECTRIC MFG. CO., 23 So. Jefferson St., Chicago—Leaflet giving a brief illustrated description of the Perry time stamp, together with a partial list of users. 3½ by 6 in.; pp. 4.

Turret Lathes.

INTERNATIONAL MACHINE TOOL CO., Indianapolis—Folders containing description and specifications of full swing turret lathes. Illustrated.

Valves.

KENNEDY VALVE MFG. CO., Elmira, N. Y.—Illustrated catalogue and price list describing valves, hydrants, etc. 9 by 5¼ in.; pp. 132.

WALCH & WYETH, 87 Lake St., Chicago—Catalogue illustrating and describing the Erwood straightway swing gate valve. 6¼ by 7 in.; pp. 16.

MONARCH VALVE & MFG CO., Warren, Mass.—Catalogue and price list illustrating and describing brass and iron body valves. 9 by 6 in.; pp. 88.

AMERICAN STEAM GAUGE & VALVE MFG. CO., Boston—Catalogue illustrating and describing pop safety, cylinder relief, water relief valves, etc., together with tables giving dimensions, prices, etc. 6 by 9 in.; pp. 90.

GOLDEN-ANDERSON VALVE SPECIALTY CO., Fulton Bldg., Pittsburg—Catalogue No. 11 illustrating and describing, with prices and sizes, cushioned non-return valves, reducing valves, steam traps, etc. 5½ by 8½ in.; pp. 64.

MCNAB & HARLIN MFG. CO., 50 John St., New York—Catalogue and price list describing brass and iron body valves and cocks and brass fittings for steam, water and gas; cast iron fittings, etc. Illustrated and indexed. 5 by 7 in.; pp. 286.

Wheel Barrows.

ARCHER IRON WORKS, 34th Place & Western Ave., Chicago—Catalogue describing steel wheelbarrows, together with dimensions and prices. Ore and coke barrows are also treated. Illustrated. 5¼ by 8½ in.; pp. 24.

Wire Rope.

AMERICAN STEEL & WIRE CO., Chicago.—Pamphlet devoted to an illustrated description of wire rope for all purposes, together with tables giving dimensions, prices, etc. 3¼ by 6¼ in.; pp. 42.

TRENTON IRON CO., Trenton, N. J.—Cloth bound catalogue treating of the applications of wire rope to transportation, power transmission, etc. Also illustrates and describes the Bleichert system of wire rope tramways. 5½ by 8 in.; pp. 52.

Wood Pipe.

WYCKOFF SUPPLY CO., Elmira, N. Y.—Catalogue containing an illustrated description of machine-made wood-stave pipe for water works systems, power plants, mining and railroad water supplies, etc. Also treats waterproof steam pipe covering for underground and exposed steam and hot water pipe. 6 by 9 in.; pp. 80.